Geographic
Information System

Raster Data

05 DEC, 2025

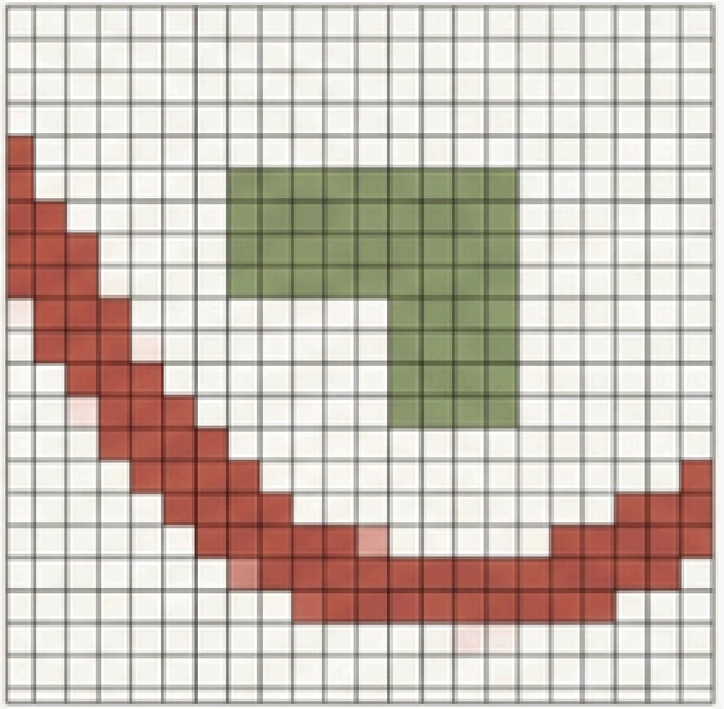
Tzu-Cheng Chang (2025)

Content

What is a Raster?

Real World

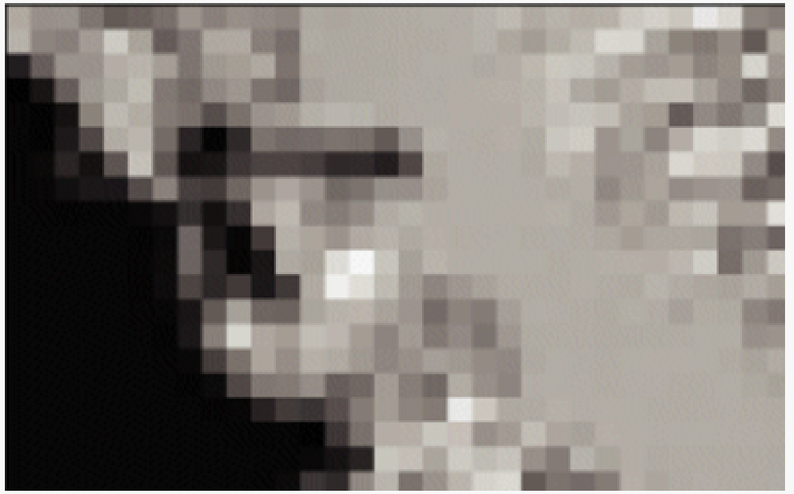
Vector



Raster

What is a Raster?

- A raster consists of a matrix of cells (or pixels) organized into rows and columns.
- Each cell contains a value representing information. E.g. Temperature, Elevation.
- Rasters are digital aerial photo, imagery from satellites, digital pictures, or scanned maps.

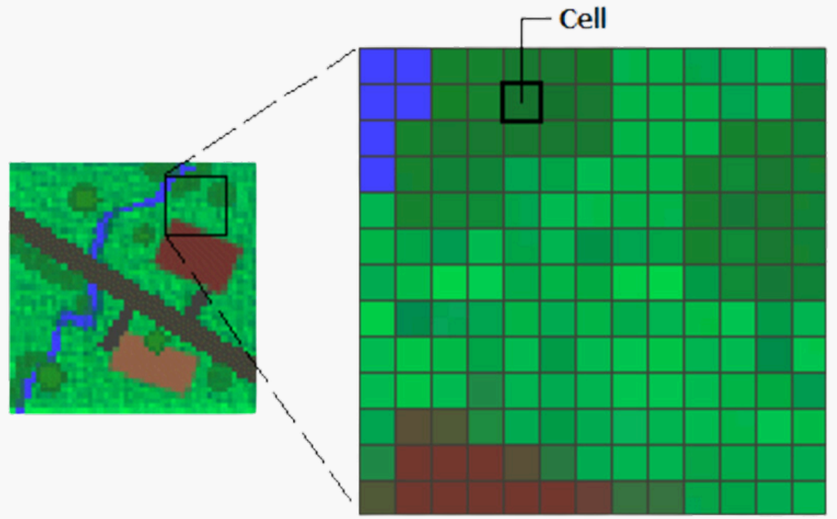


Raster Properties

3 Resolutions

- **Spatial Resolution - Clarity of detail**
- **Radiometric Resolution - Depth of information**
- **Spectral Resolution - Types of information captured**

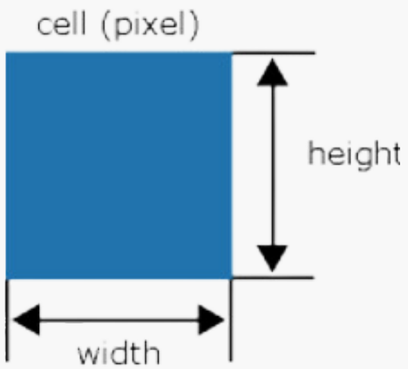
Raster Properties



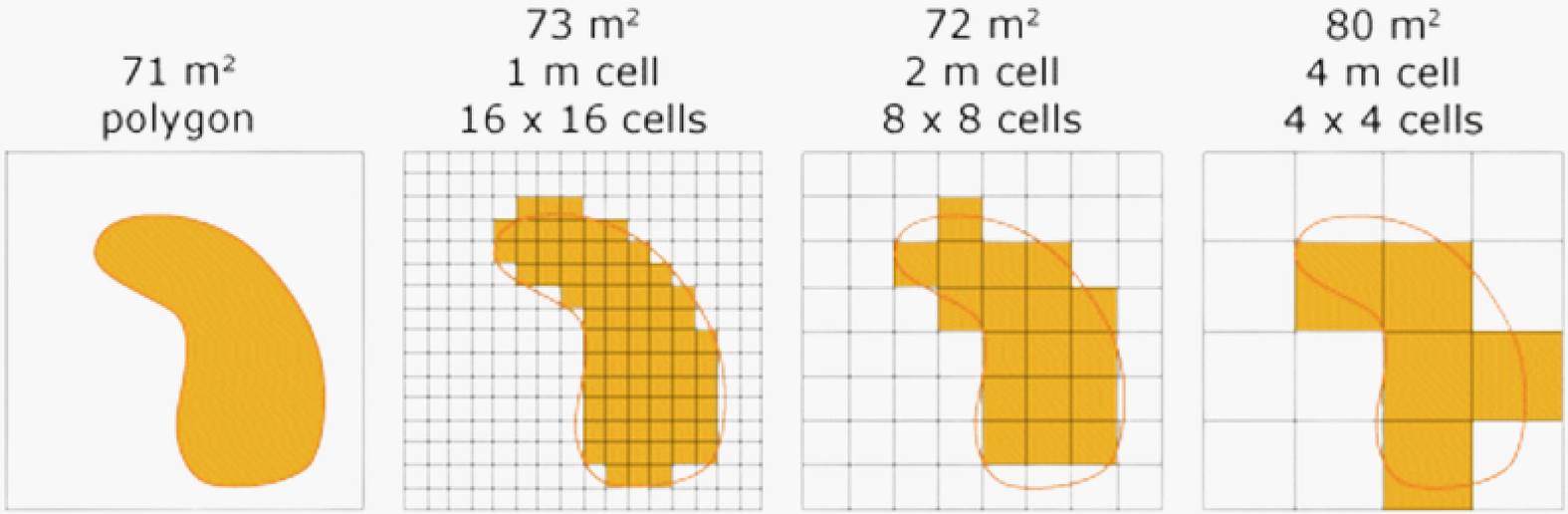
- **Cell Size**
- Bits Depth
- Bands

- **Spatial resolution is defined by the ground area covered by a pixel.**
  - **Smaller cells capture more detail and create a finer, more realistic image. However, this comes at the cost of significantly larger file sizes. The choice of resolution is a trade-off between detail and performance.**

Spatial Resolution

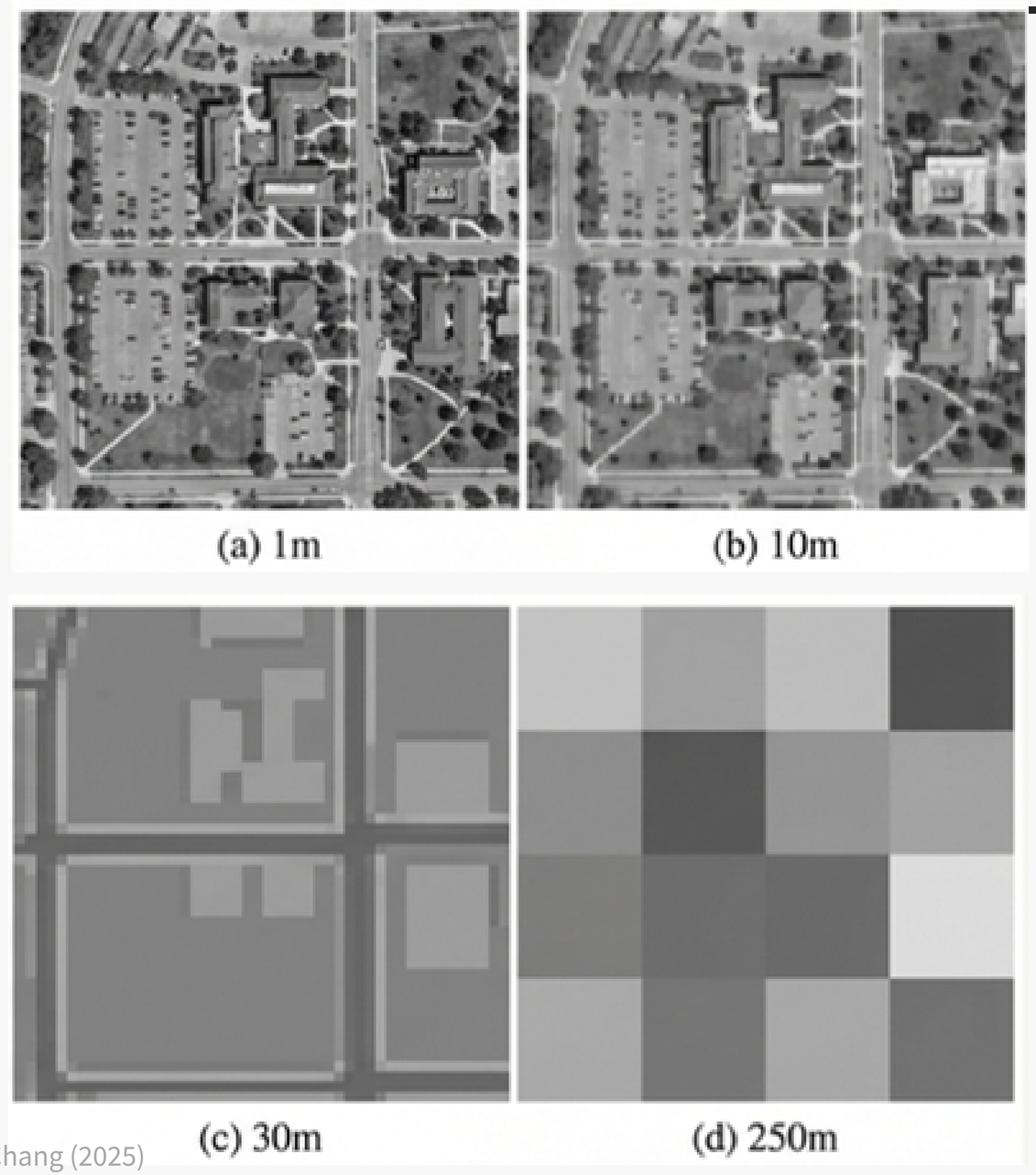


- **Cell Size**
- **Bits Depth**
- **Bands**

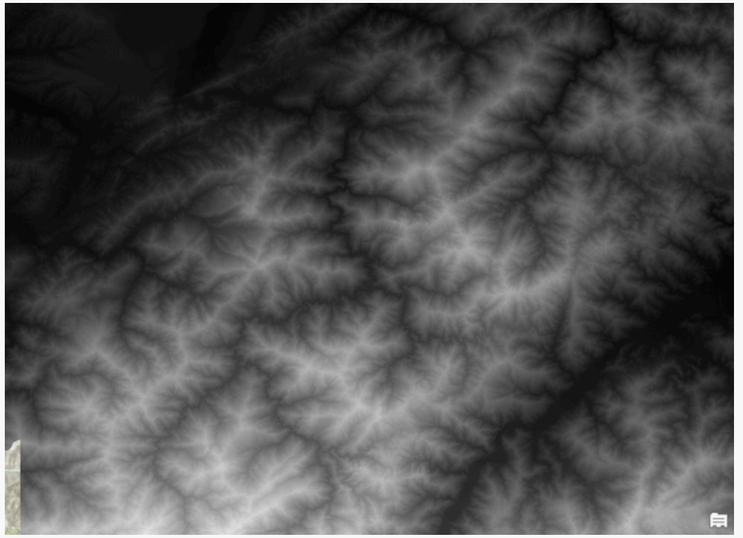


Spatial Resolution

- **Cell Size**
- **Bits Depth**
- **Bands**



Radiometric Resolution



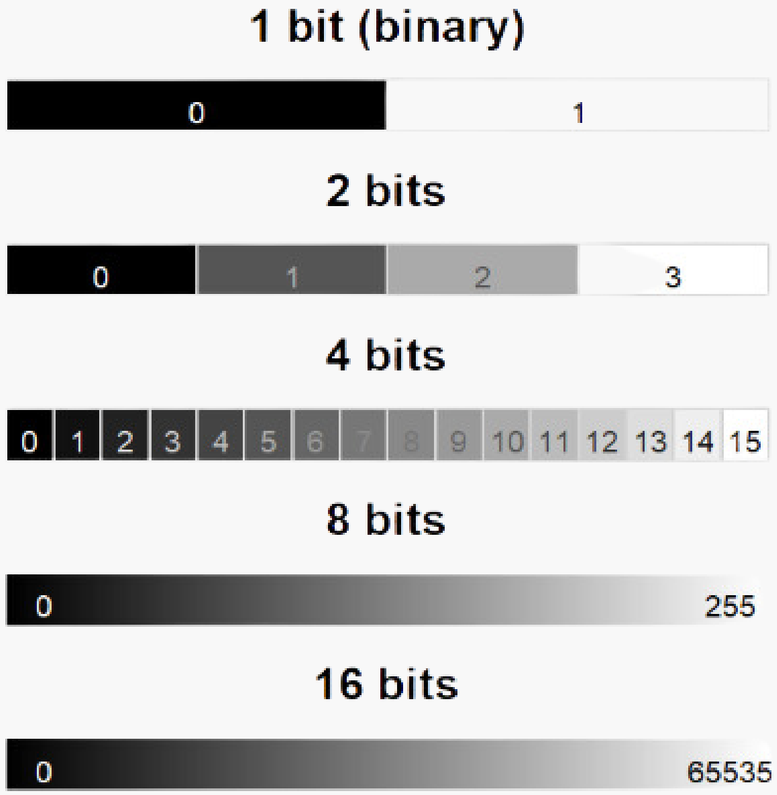
- Cell Size
- **Bits Depth**
- Bands

- **is defined by the range of values a cell can store.**
  - **Higher bit depth allows a cell to store a wider range of values, enabling it to capture more subtle variations in the measured phenomenon (e.g., surface temperature, brightness).**

Radiometric Resolution

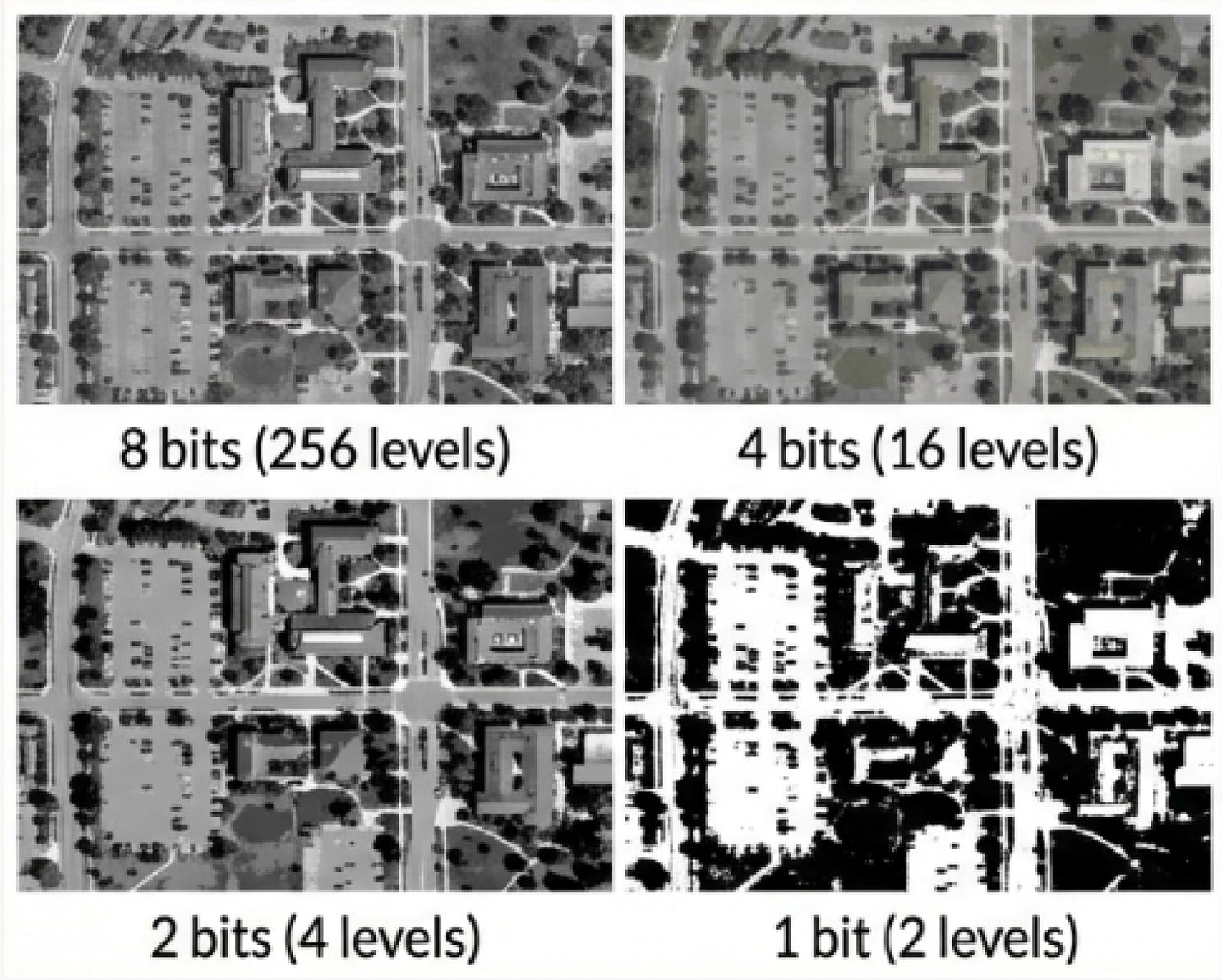
- Cell Size
- **Bits Depth**
- Bands

$$2^n$$



Radiometric Resolution

- Cell Size
- **Bits Depth**
- Bands



Spectral Resolution

Cell Size

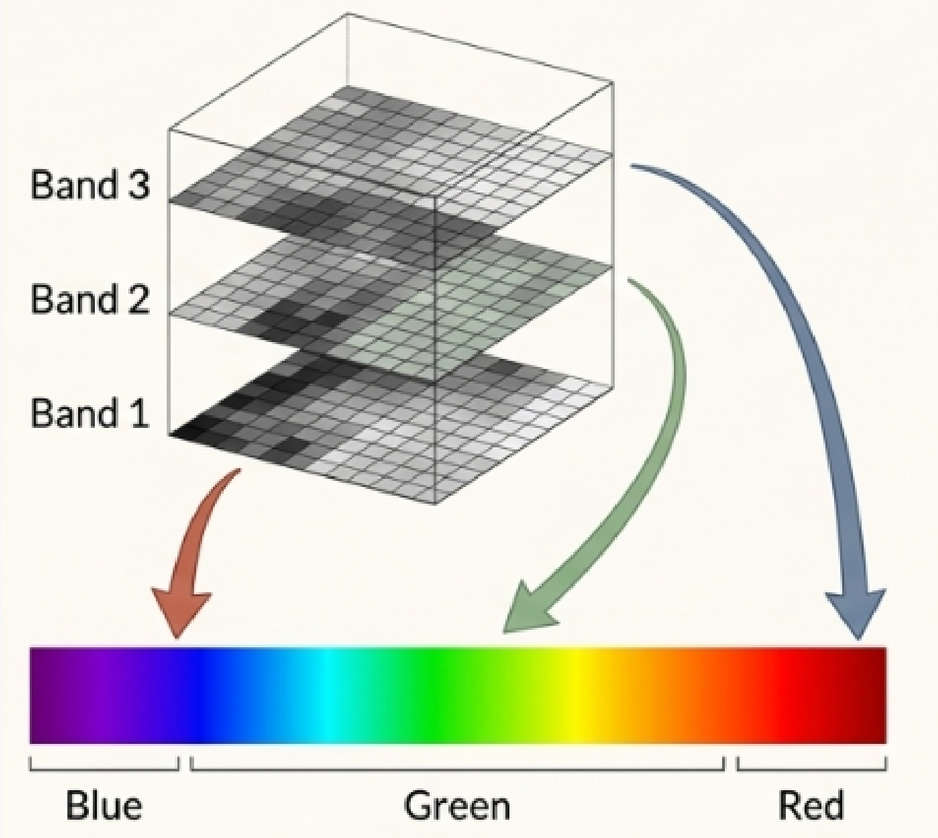
Bits Depth

Bands

- **Spectral resolution is defined by the number and width of spectral Bands a sensor can capture. Each band records energy from a specific portion of the electromagnetic spectrum.**

Spectral Resolution

- Cell Size
- Bits Depth
- **Bands**



Spectral Resolution

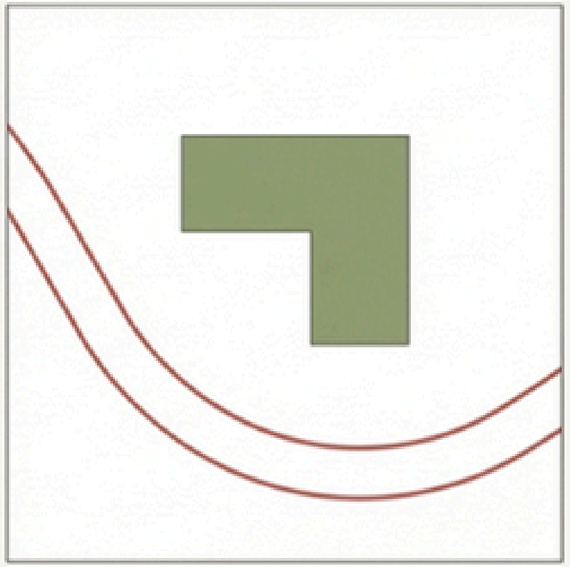
- Cell Size
- Bits Depth
- **Bands**

Channel	Landsat-8 OLI band (nms)	Center wavelength (nms)	Spatial resolution (m)
Coastal/Aerosol	Band 1 (433–453)	443	30
Blue	Band 2 (450–515)	483	30
Green	Band 3 (525–600)	560	30
Red	Band 4 (630–680)	660	30
NIR	Band 5 (845–885)	865	30
SWIR 1	Band 6 (1560–1660)	1650	30
SWIR2	Band 7 (2100–2300)	2220	30
Panchromatic	Band 8 (500–680)	640	15
Cirrus	Band 9 (1360–1390)	1375	30

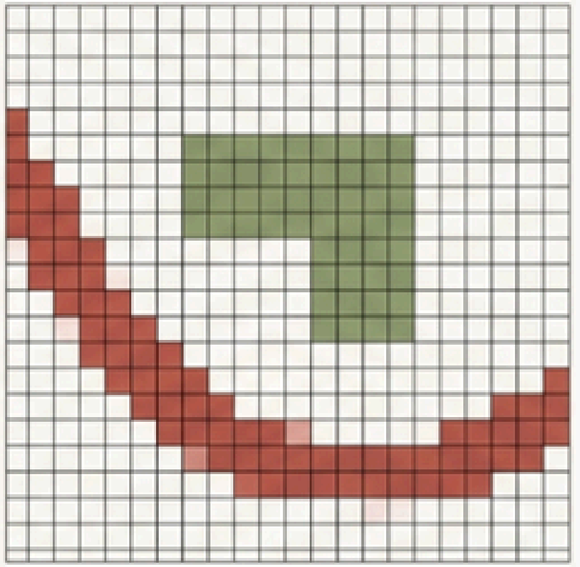
Feature vs. Raster

Raster data represents the world as a continuous surface, divided into a matrix of cells, or pixels. Each cell holds a single value representing information like elevation or temperature.

Real World



Vector



Raster

Raster Application

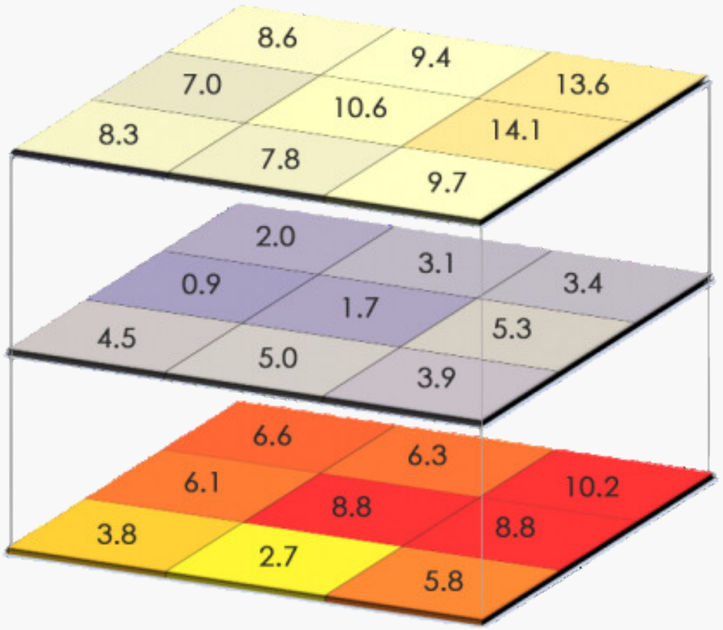
a. DEM / DTM

b. Imagery

Map Algebra

- Map algebra basically involves doing math with maps.
- NODATA / Null are not belongs to values.
- It can be processed between different band / raster layers.
- In Map Algebra, coordinate system matters!

  Before doing Map Algebra, must make sure features have correct coordinate system.



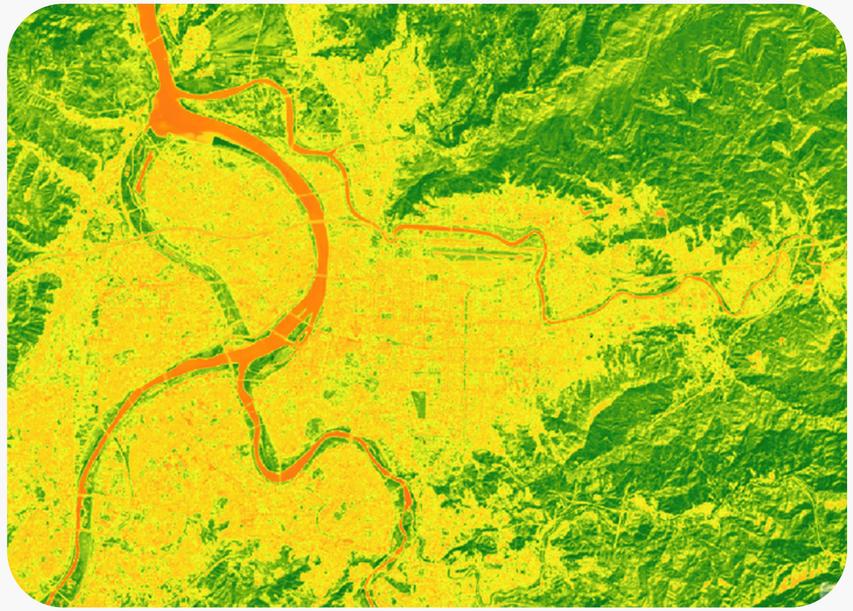
NDVI

(Normalized Difference Vegetation Index)

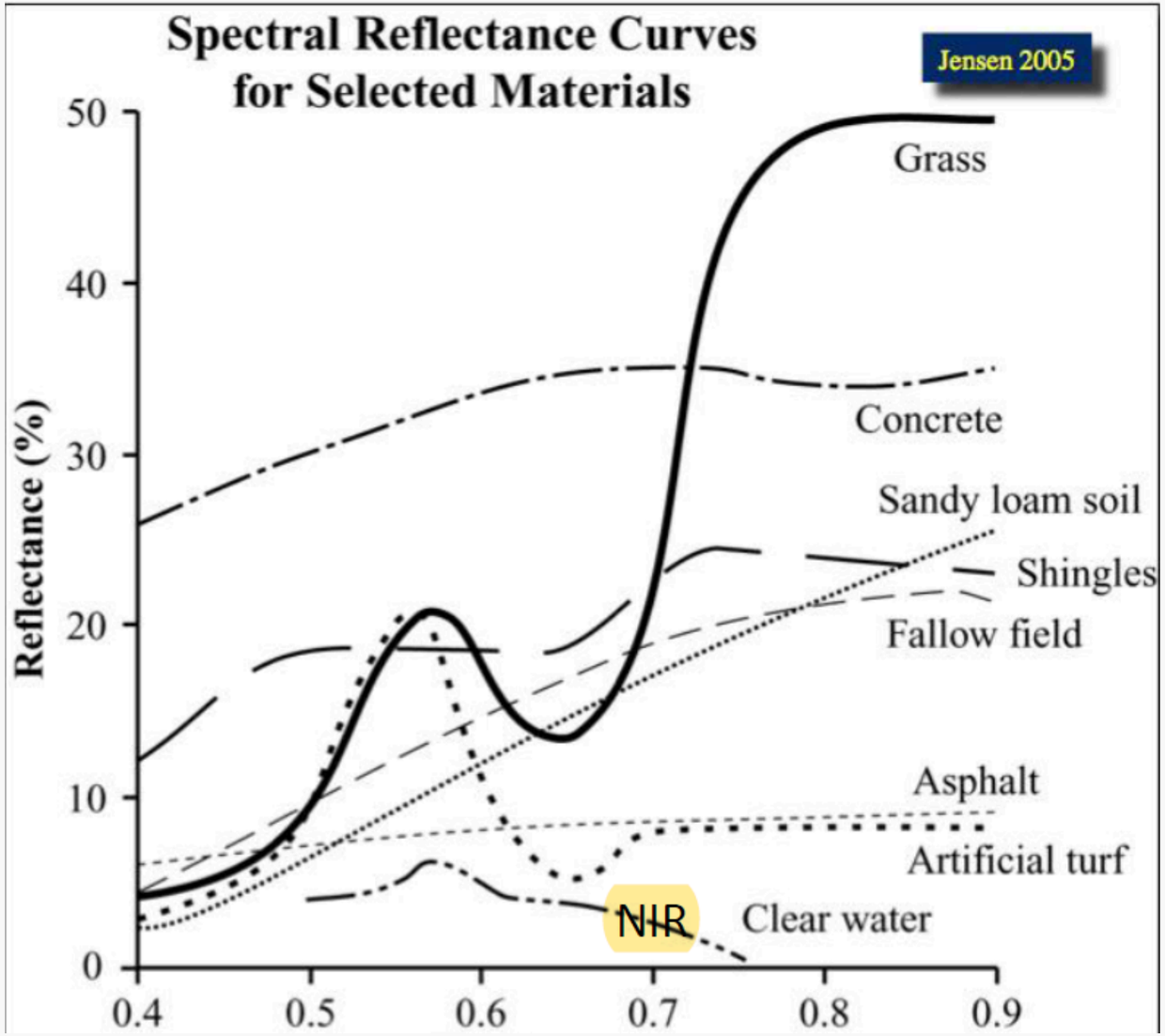
- NIR (Nearest InfraRed) band is sensitive with plants.
- Plants absorb lots of Red radiation.

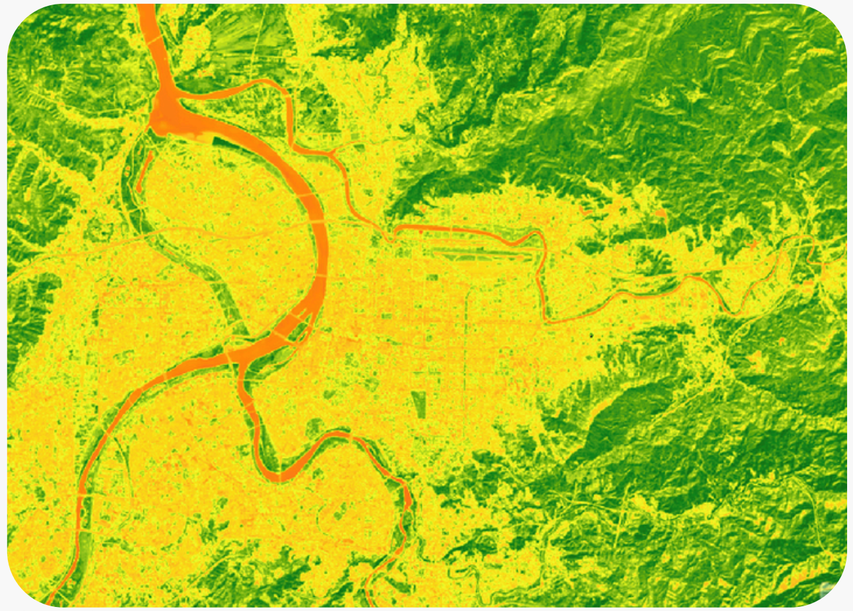
- By using Red Band and NIR band's reflectance, we can calculate a value to evaluate the condition of plants growth.

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$



NDVI

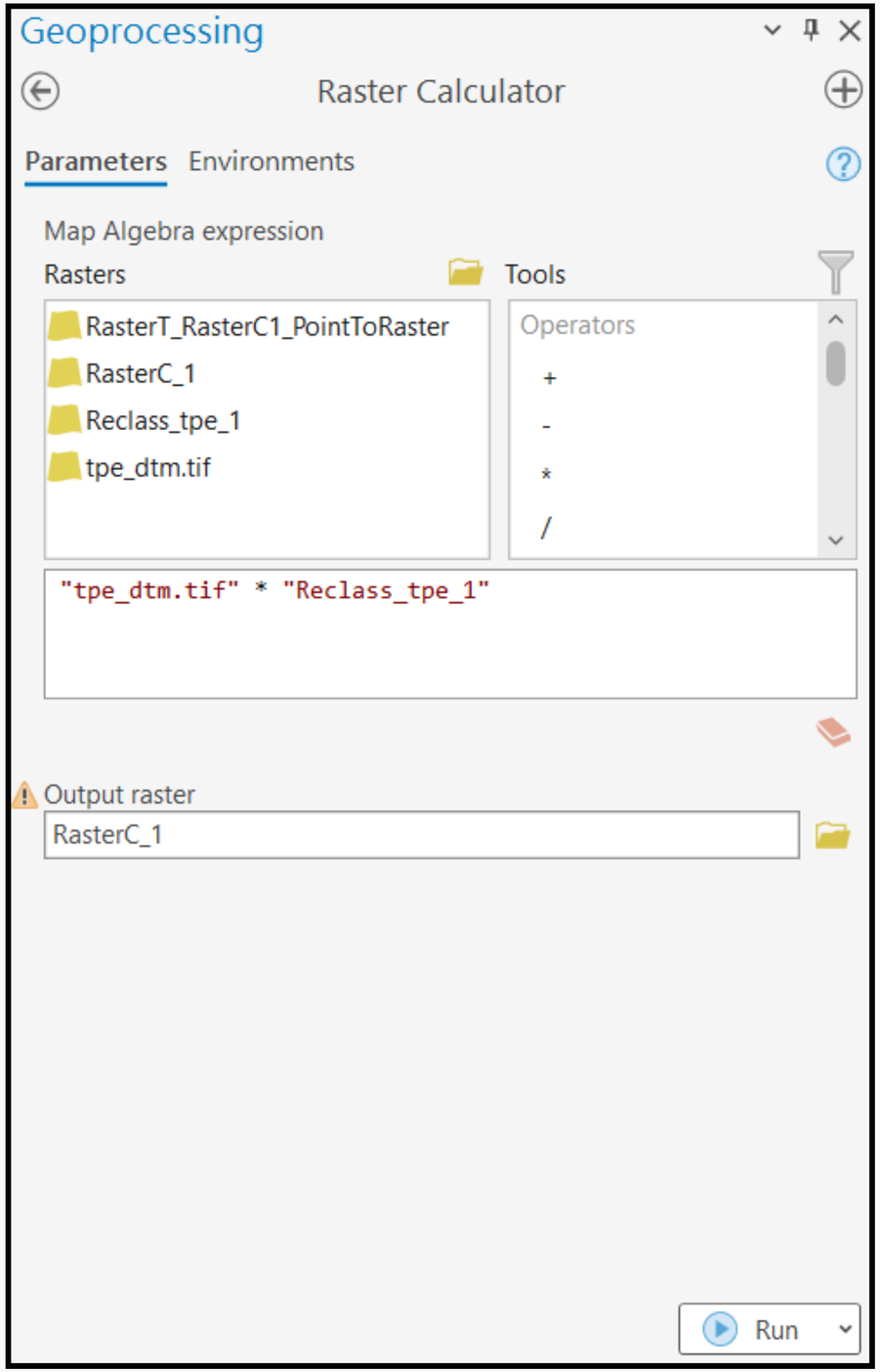

Spectral Reflectance Curves
for Selected Materials
Jensen 2005
Reflectance (%)
50
40
30
20
10
0
0.4
0.5
0.6
0.7
0.8
0.9
Grass
Concrete
Sandy loam soil
Shingles
Fallow field
Asphalt
Artificial turf
NIR
Clear water



Tools in ArcGIS Pro

Raster Calculator

- **Raster Calculator can build and run a single map algebra expression using Python syntax.**



Raster Calculator

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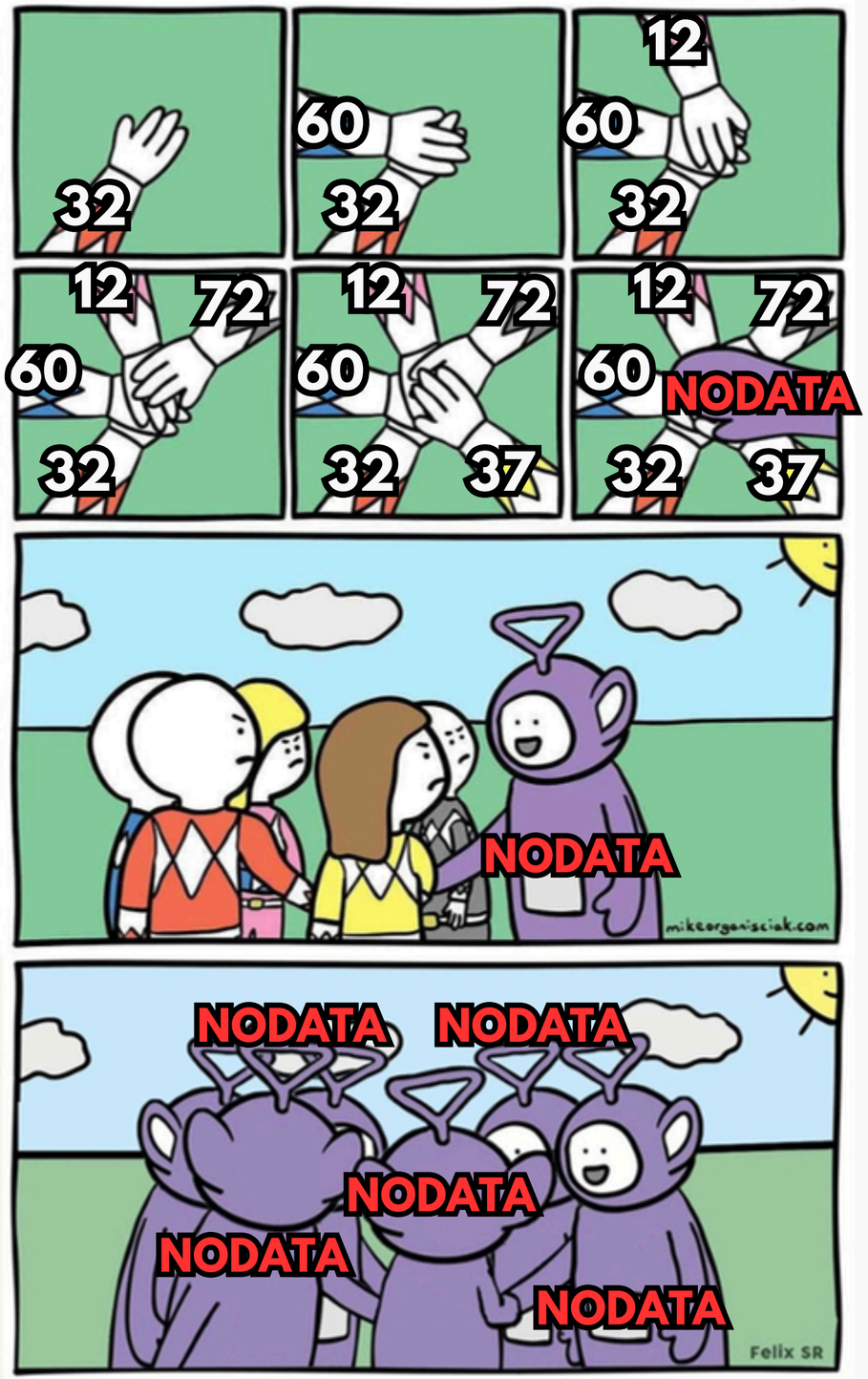
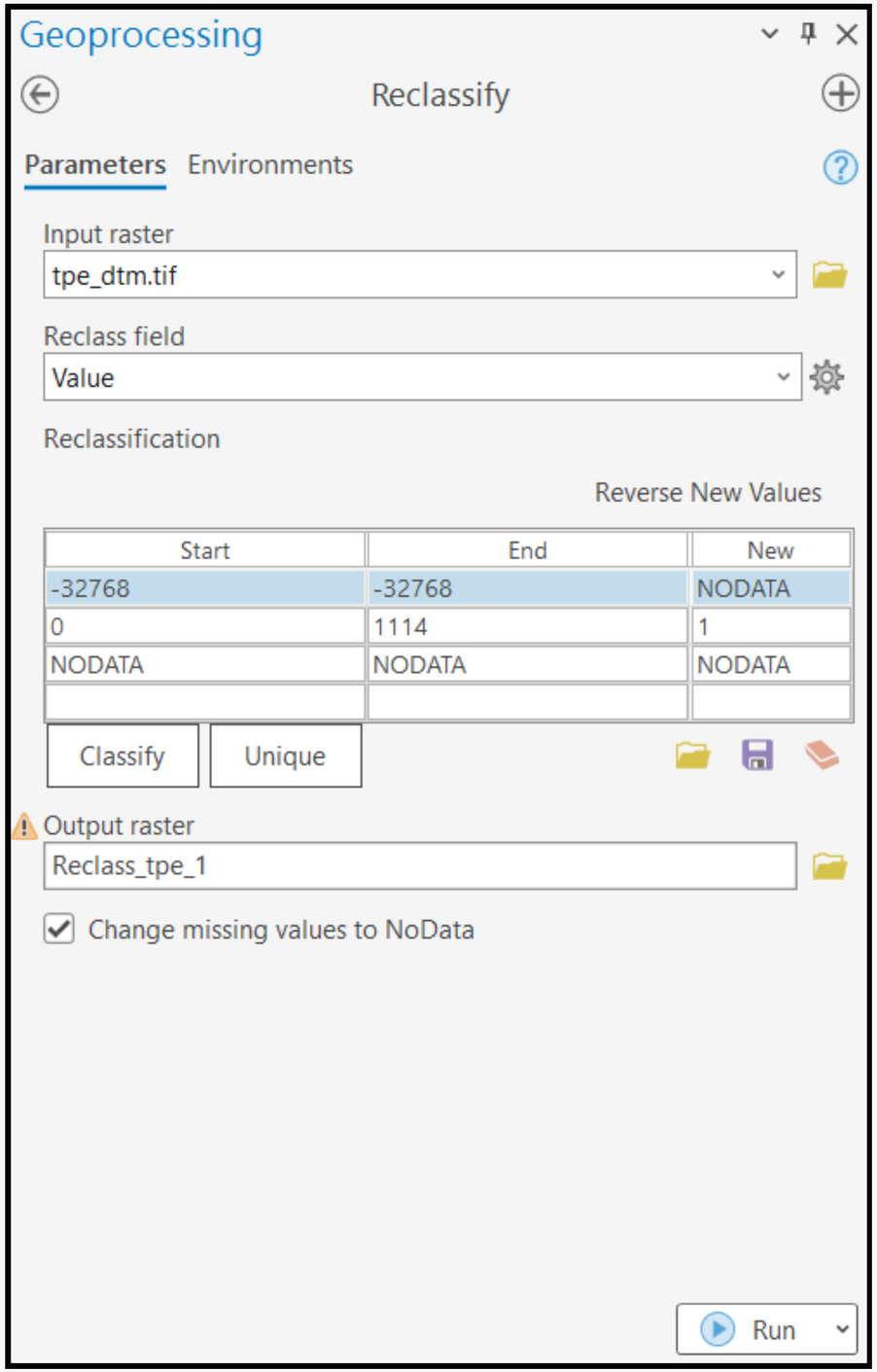
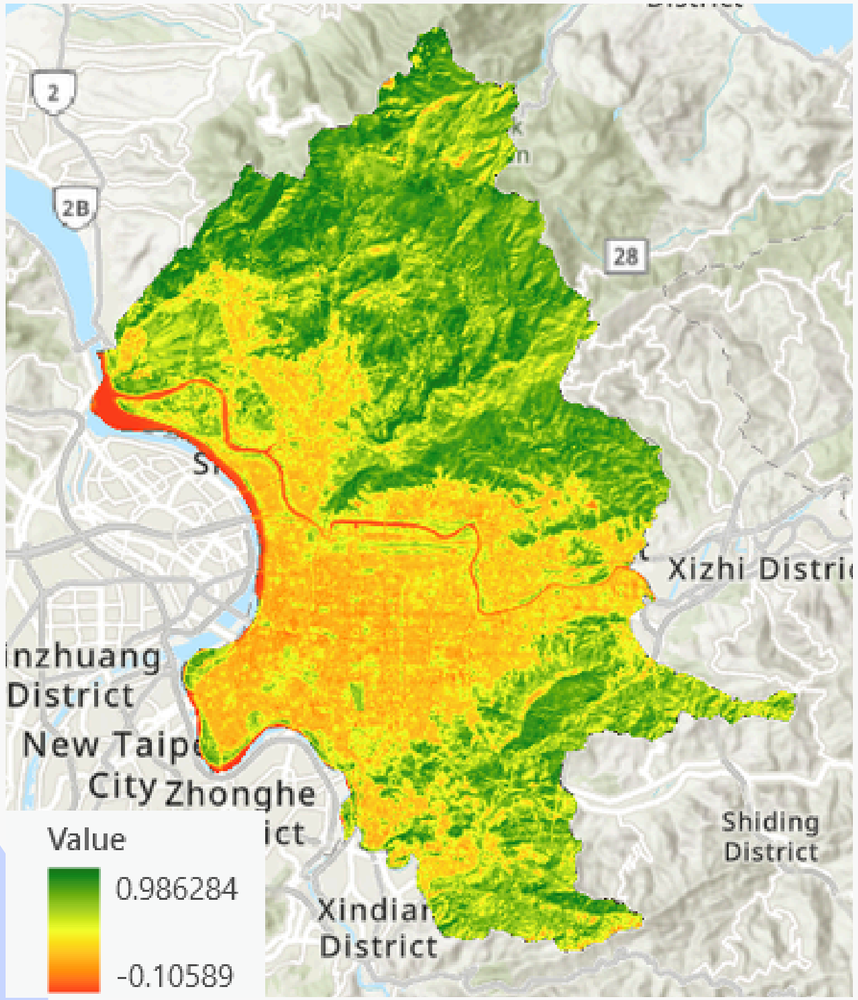


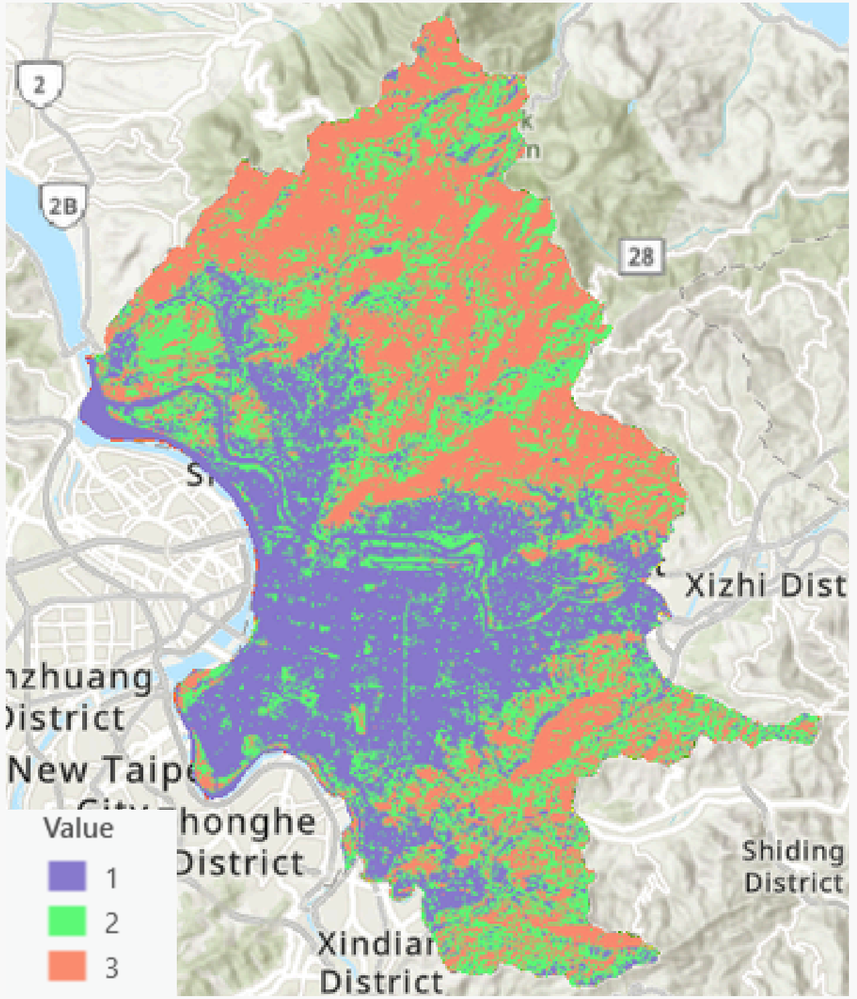
Reclassify

- **Reclassifies (or changes) the values in a raster.**



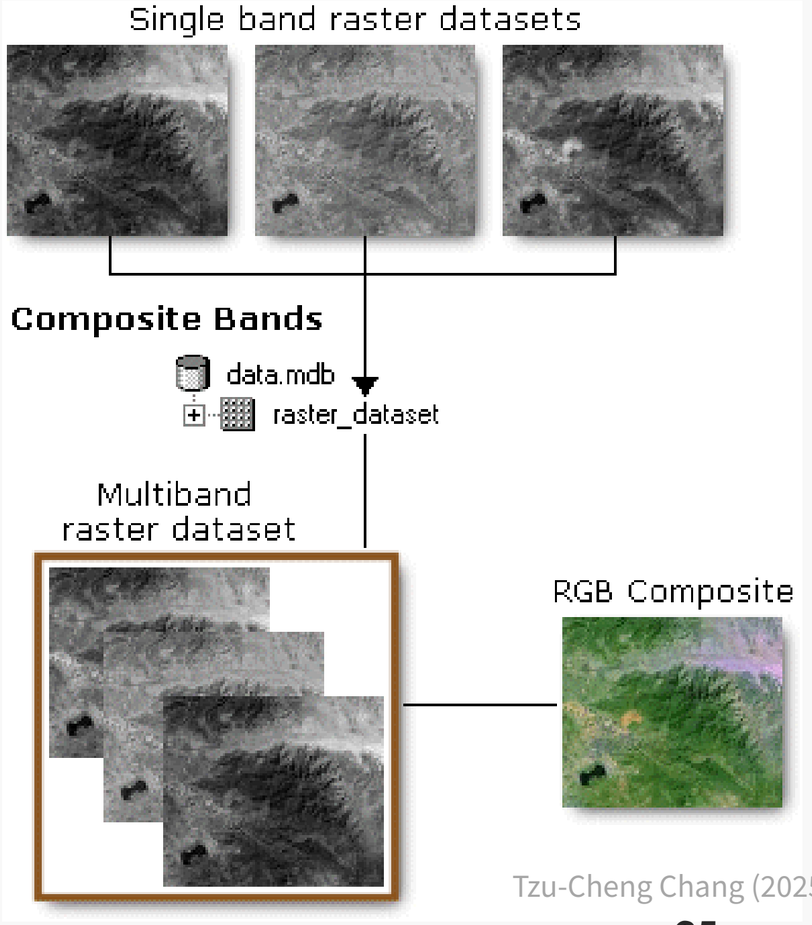
Reclassify

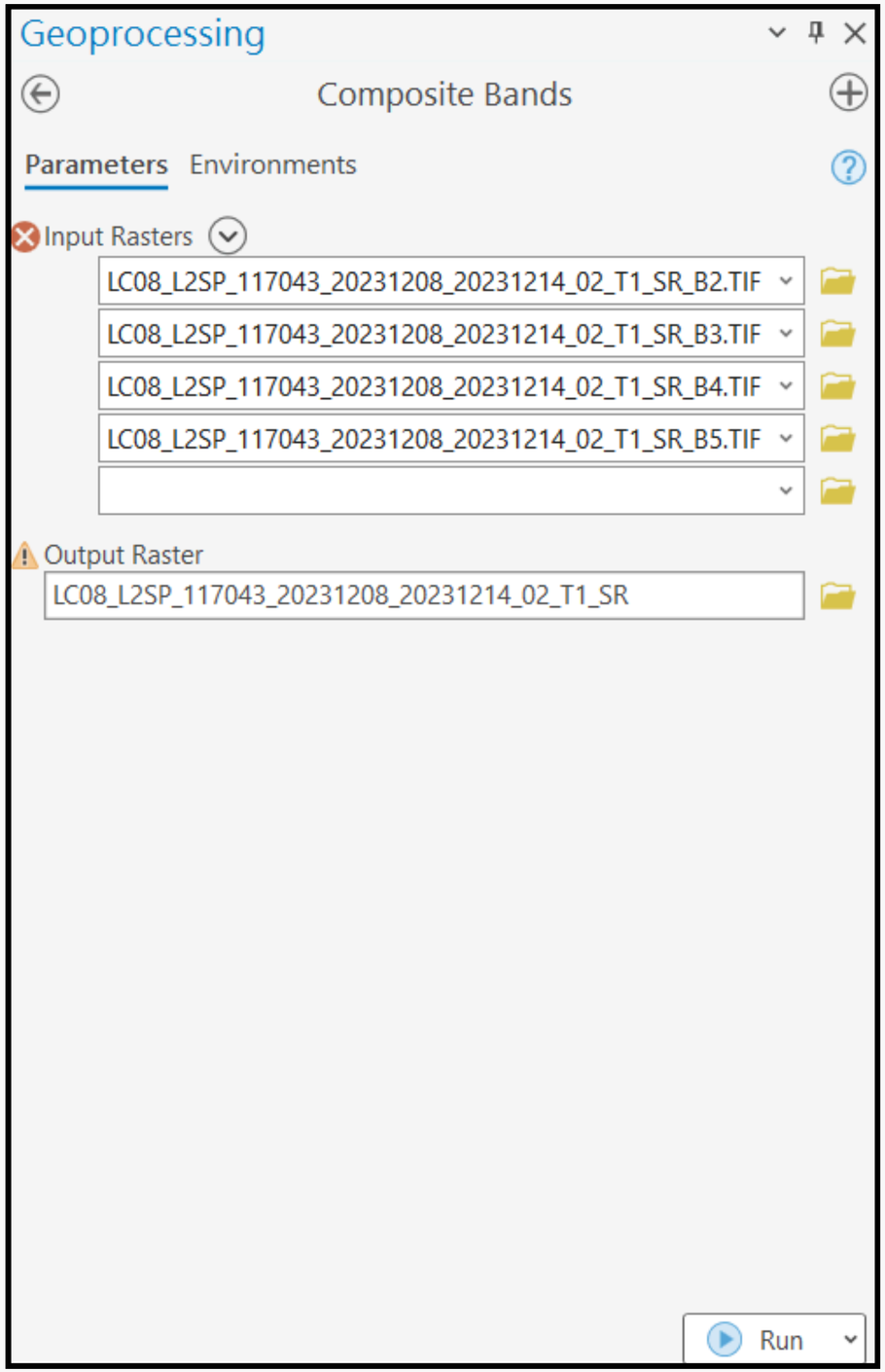

2
2B
28
Xizhi Distri
nzhuang
District
New Taipe
City
Zhonghe
ict
Shiding
District
Xindian
District
Value
0.986284
-0.10589


2
2B
28
Xizhi Dist
nzhuang
District
New Taipe
honghe
District
Shiding
District
Xindian
District
Value
1
2
3

Composite Bands

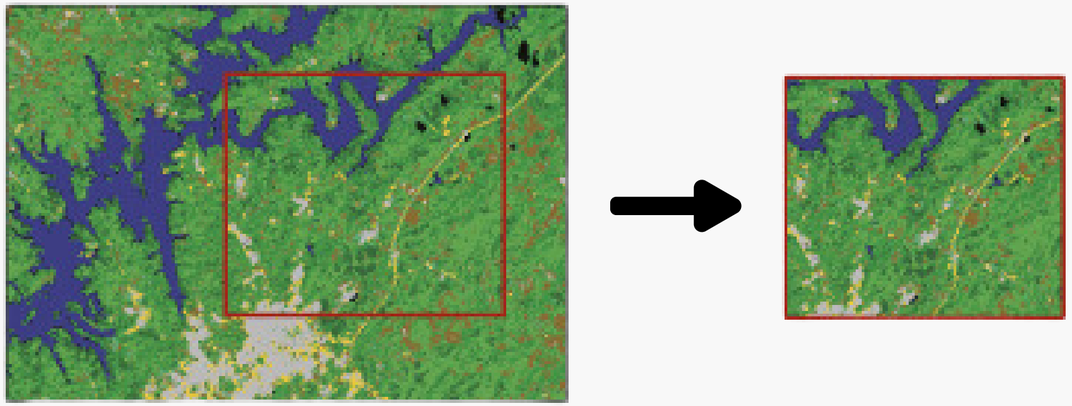
- **Creates a single raster dataset from multiple bands.**

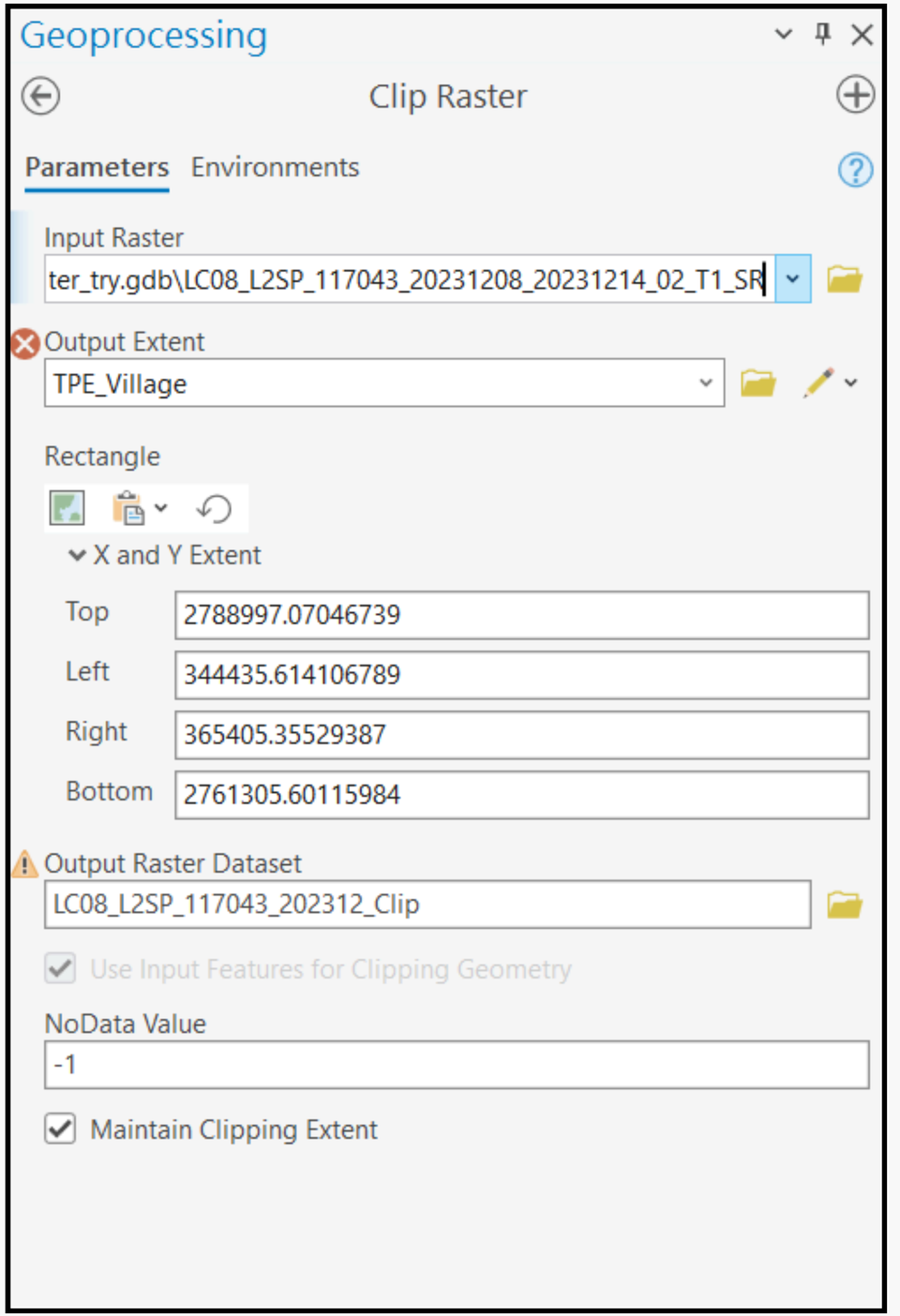




Clip Raster

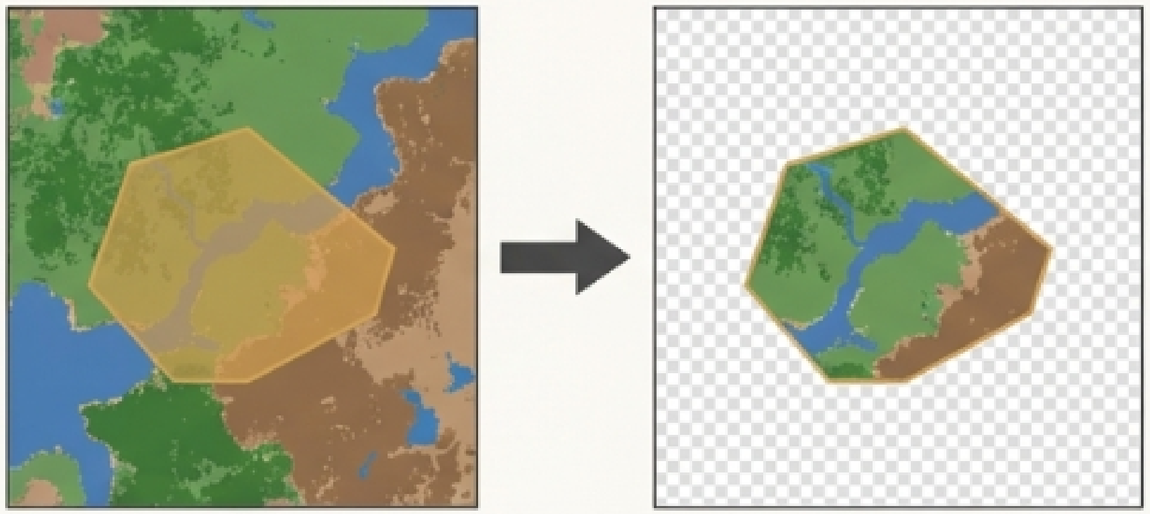
- **Cuts out a portion of a raster dataset, mosaic dataset, or image service layer.**





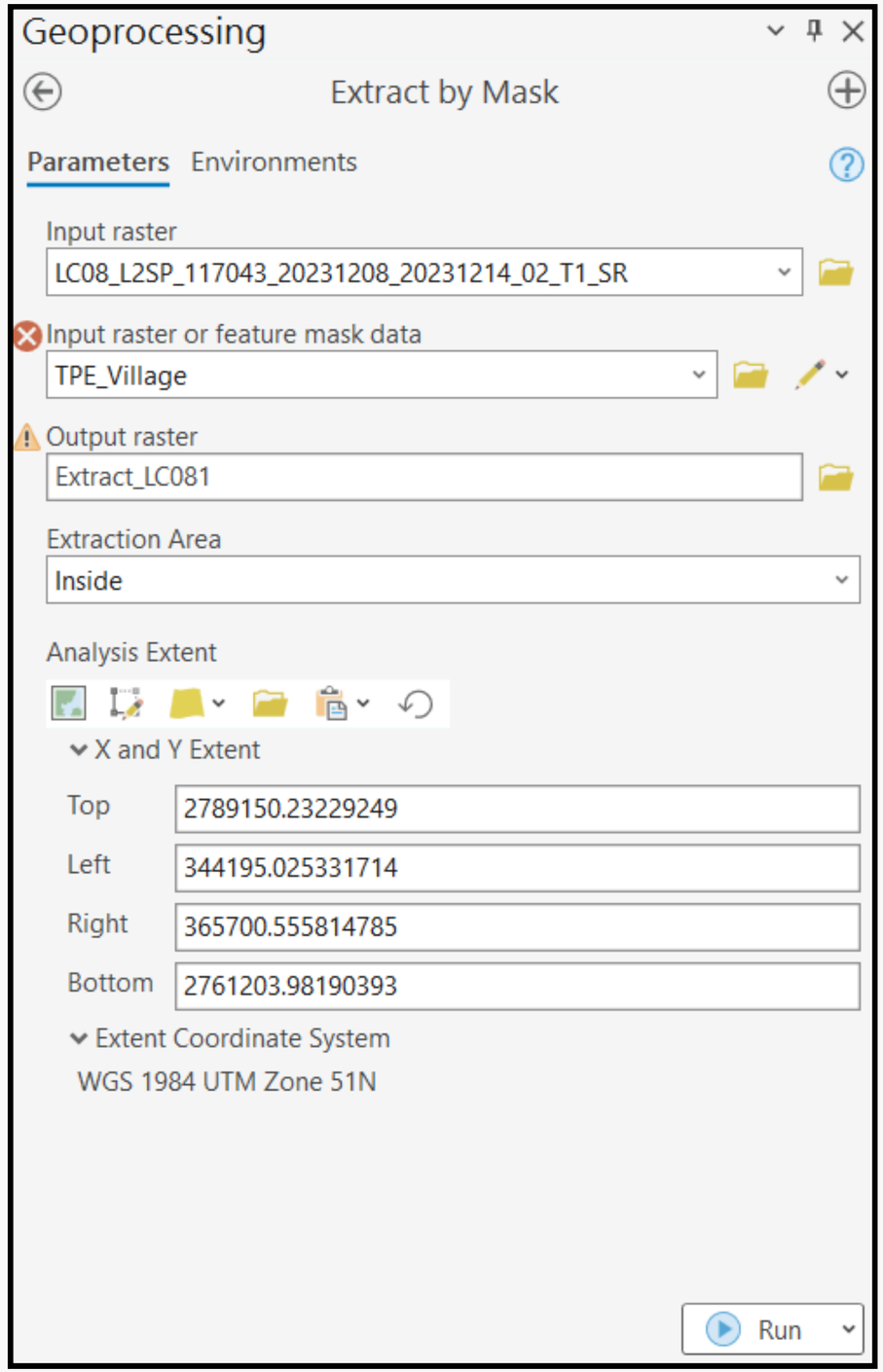
Extract by Mask

- **Extracts the cells of a raster that correspond to the areas defined by a mask.**



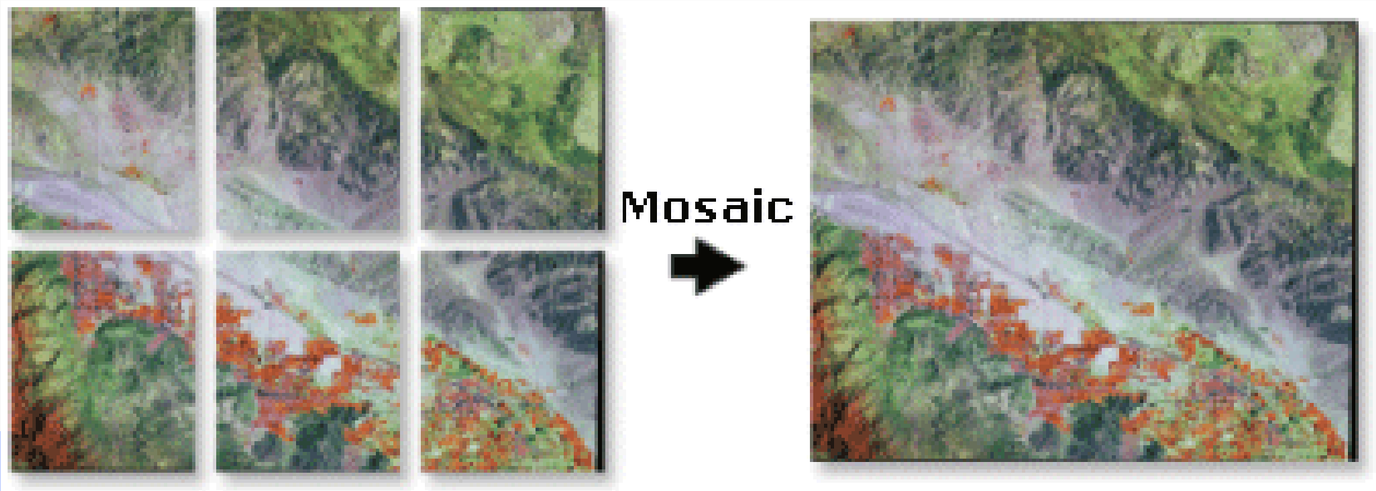
Before

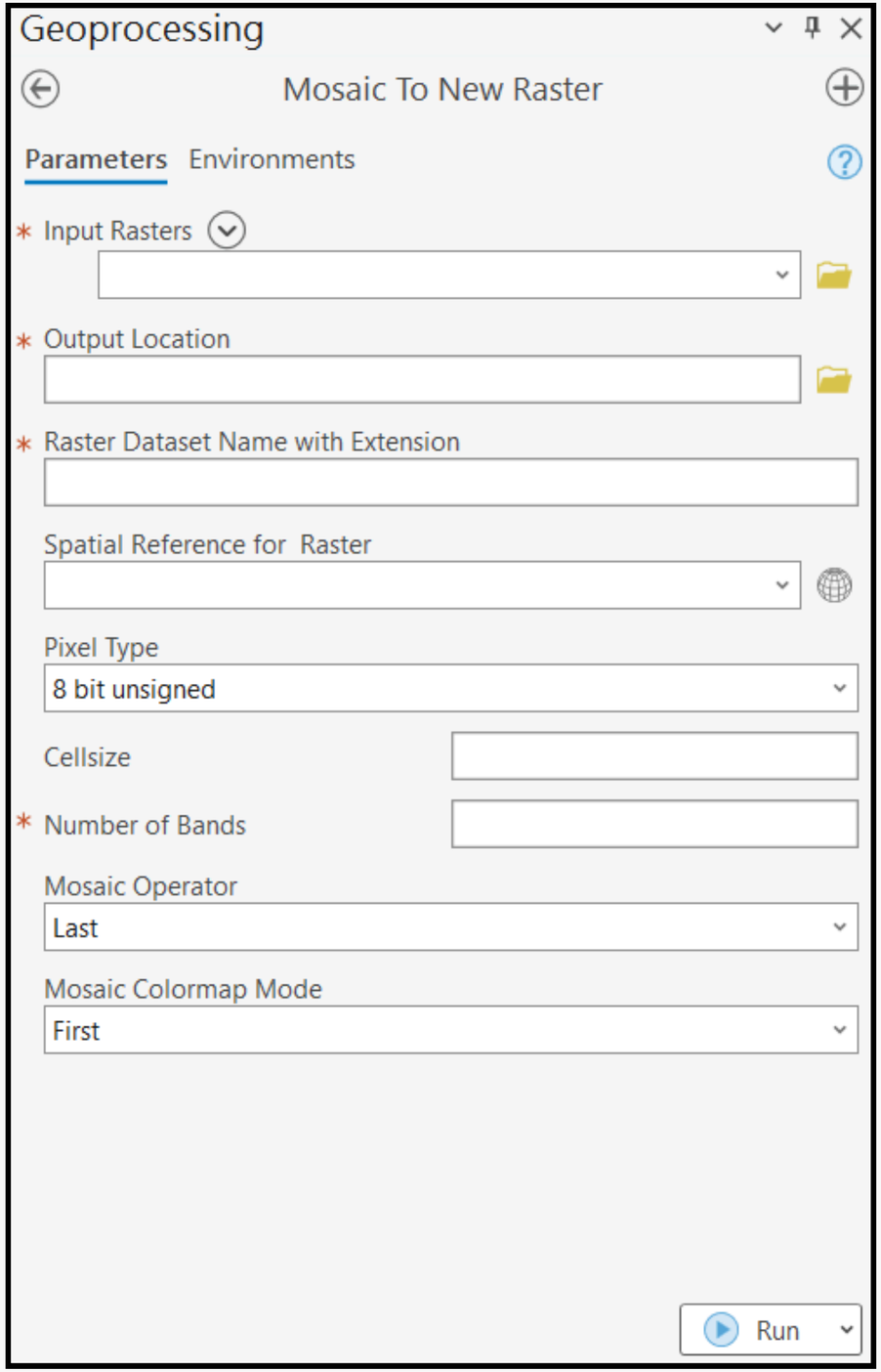
After



Mosaic to New Raster

- **Merges multiple raster datasets into a new raster dataset.**

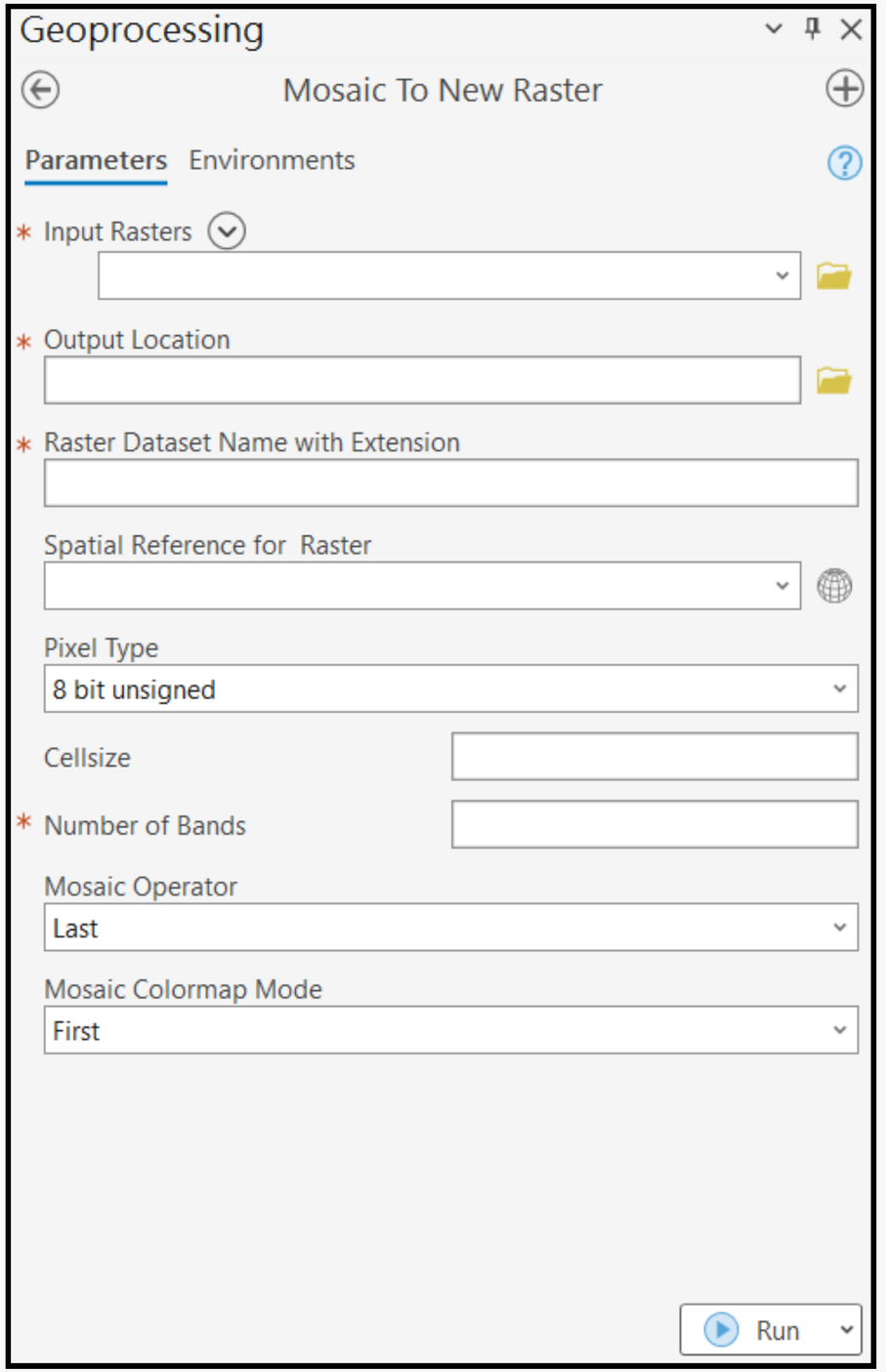




Mosaic to New Raster

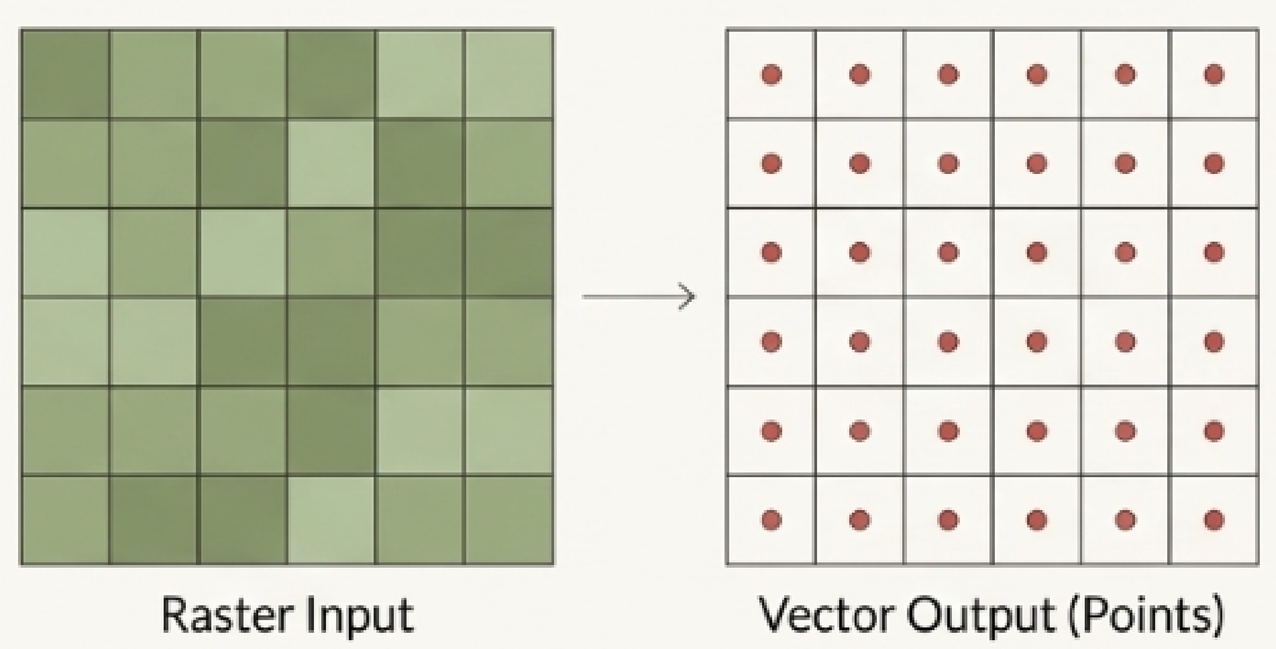
- **Merges multiple raster datasets into a new raster dataset.**

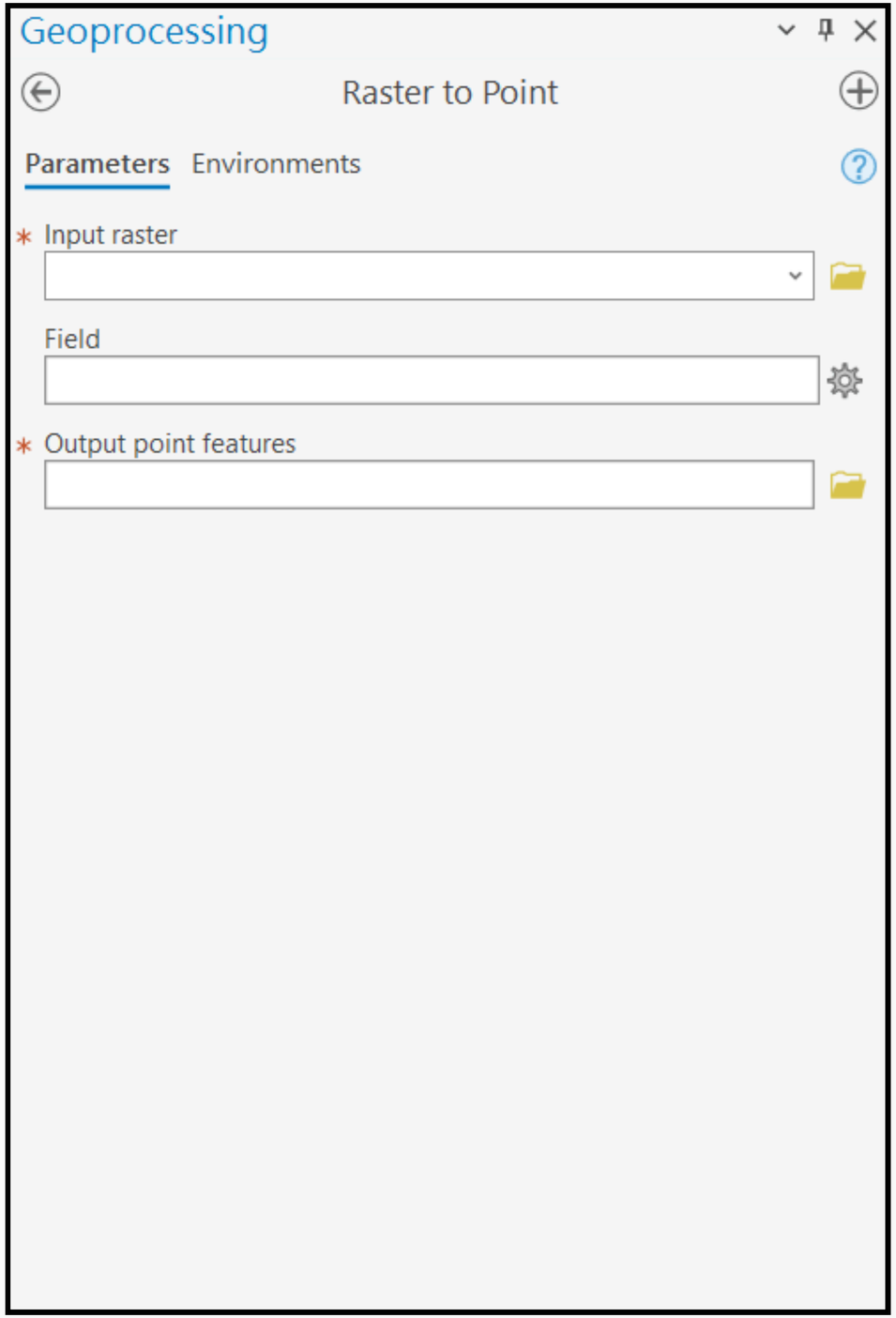
- **Pixel type => Depth e.g. 8bit**
  - **Unsigned: 0 ~ 255**
  - **Signed: -128 ~ 127**



Point Raster Conversion

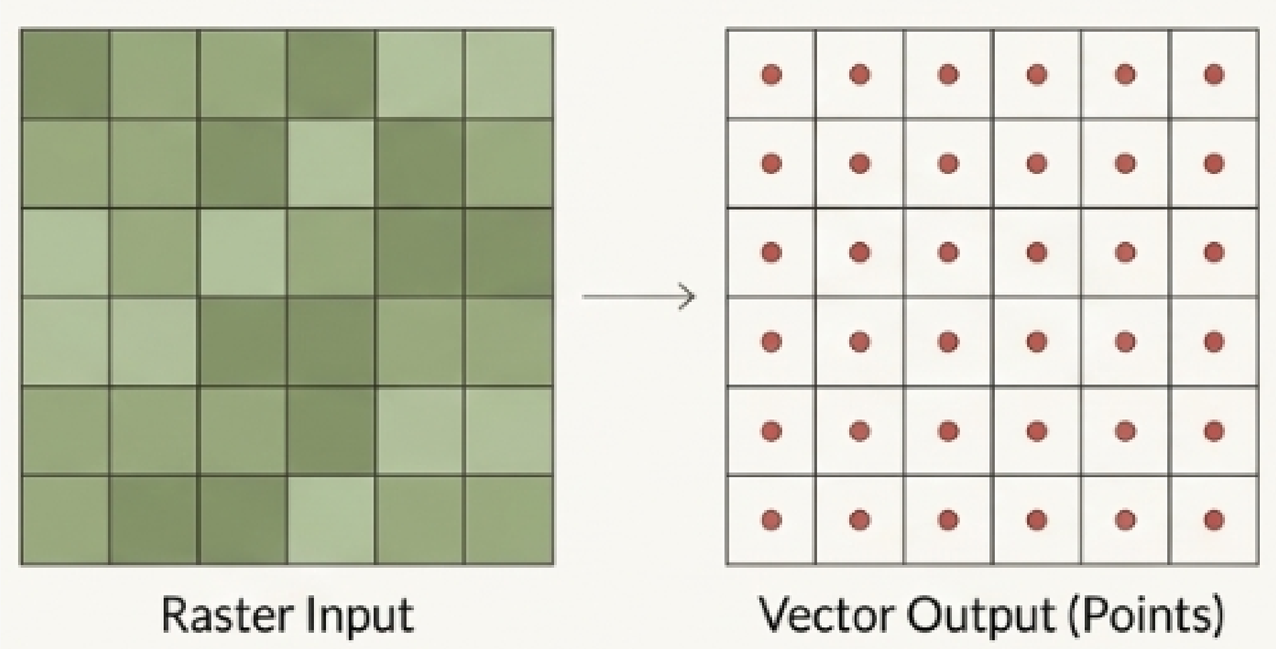
- **Converts a raster dataset to point features.**

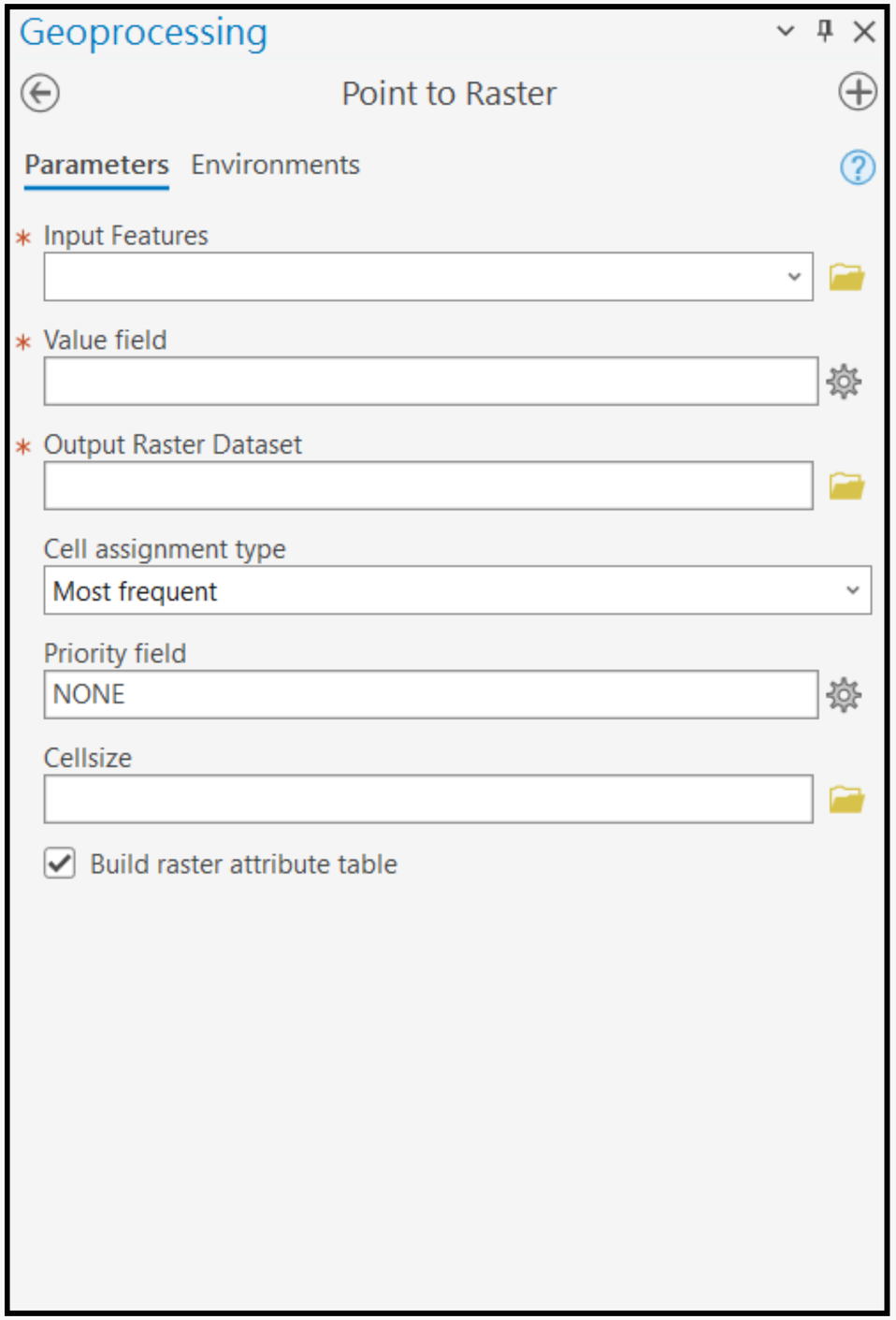




Point Raster Conversion

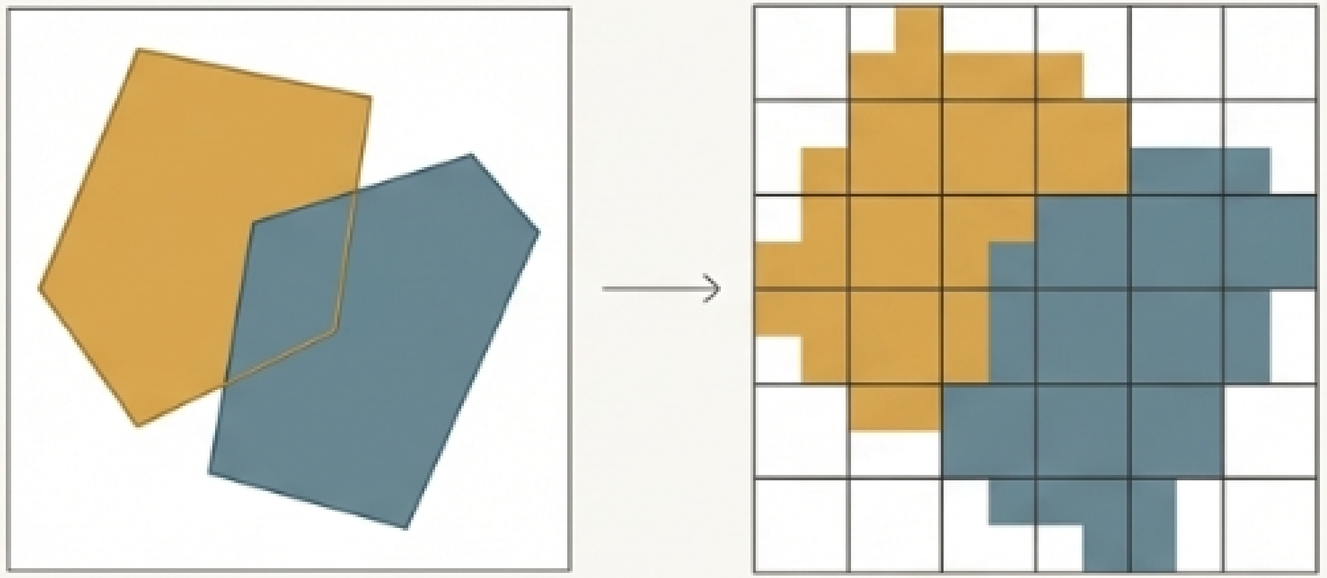
- **Converts a point features to raster dataset.**

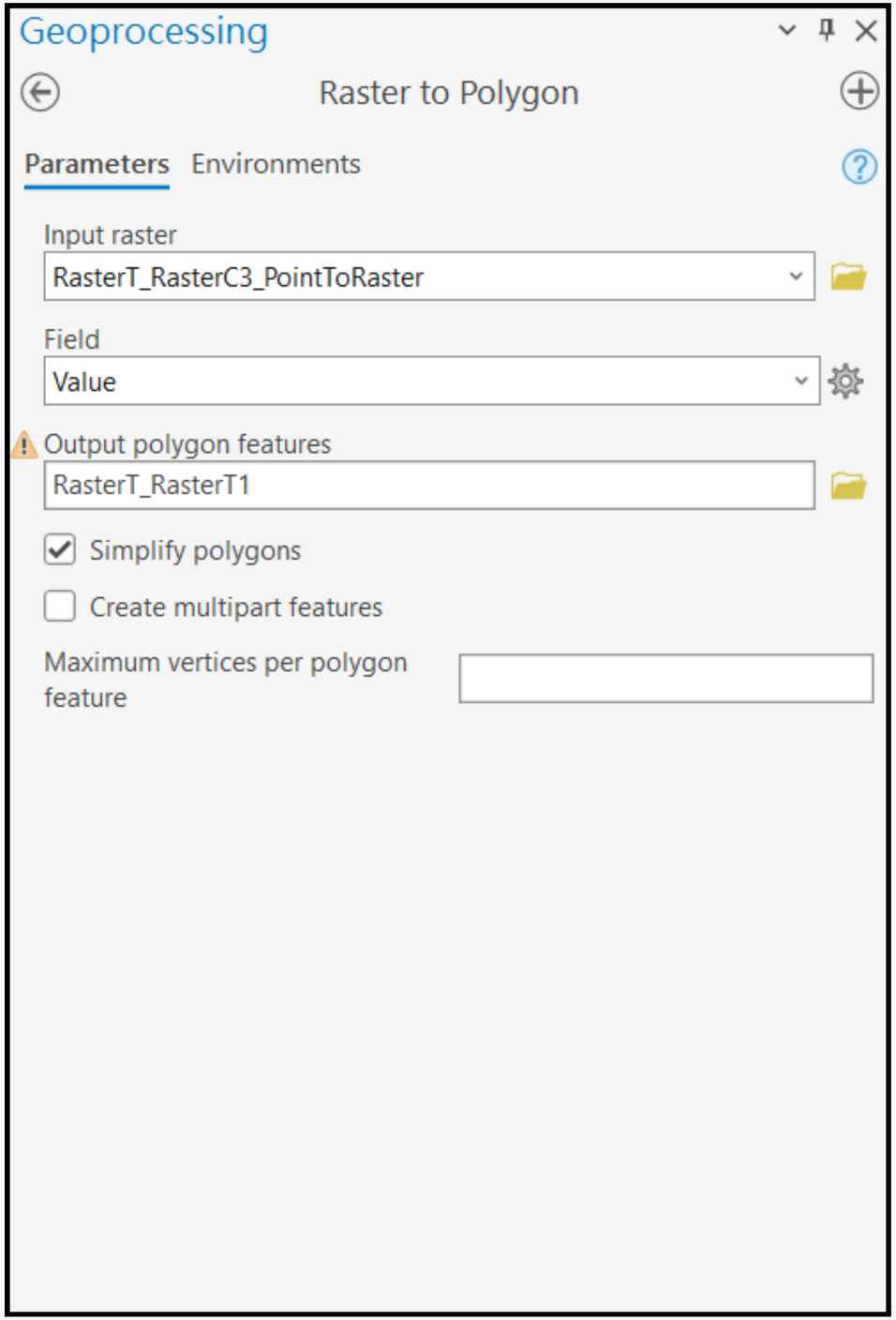




Polygon Raster Conversion

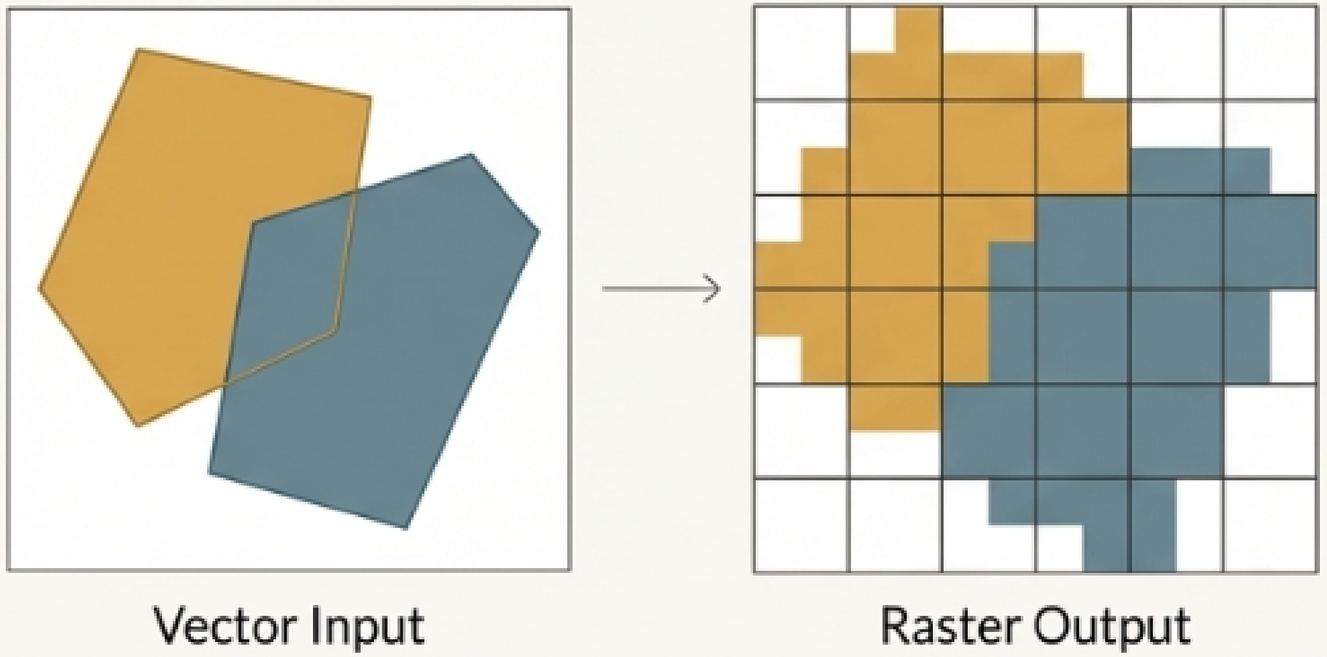
- **Converts a raster dataset to features.**

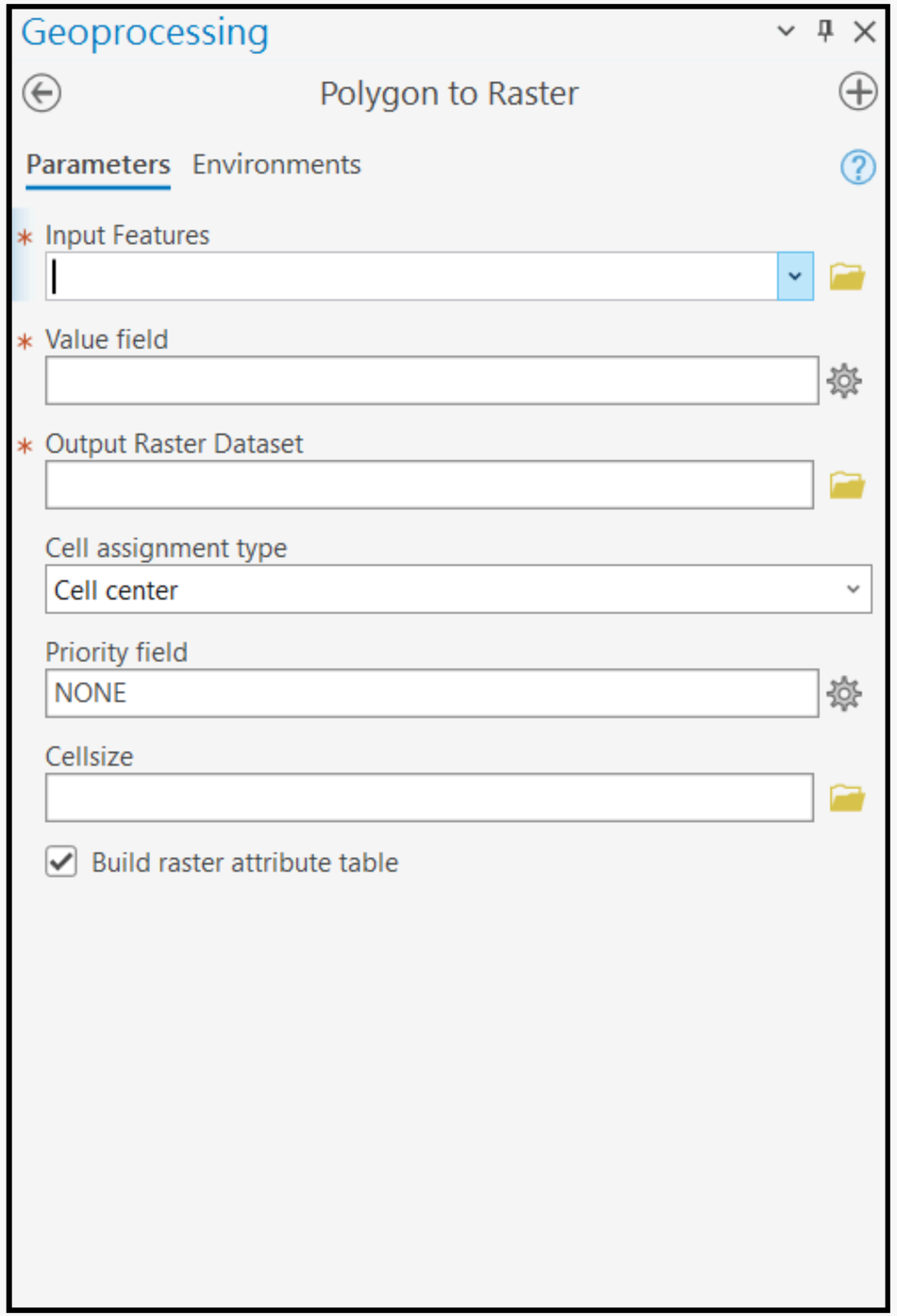




Polygon Raster Conversion

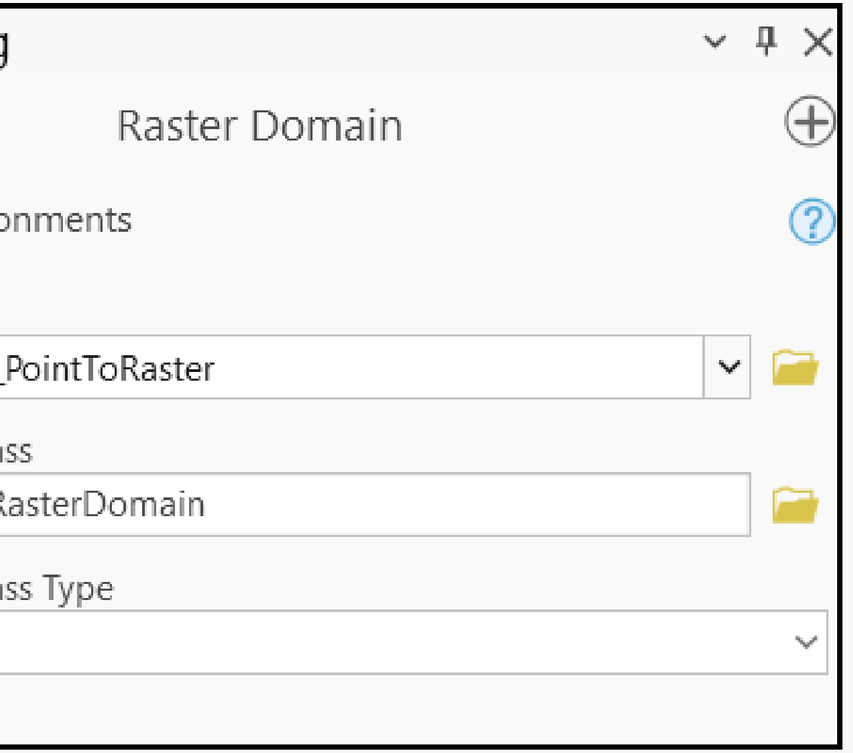
- **Converts a features to raster dataset.**

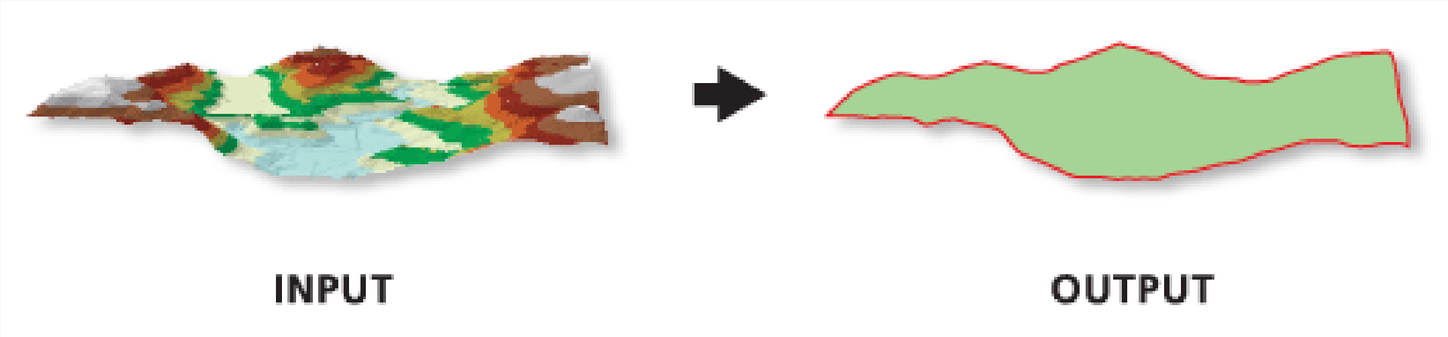




Raster Domain

- **Converts a raster dataset to features.**





Raster Operation

Flooding Potential Area

- **Lab Practice I - Calculate total non-affected population with 20m height flooding area.**

Using Population csv to calculate each village’s population density.

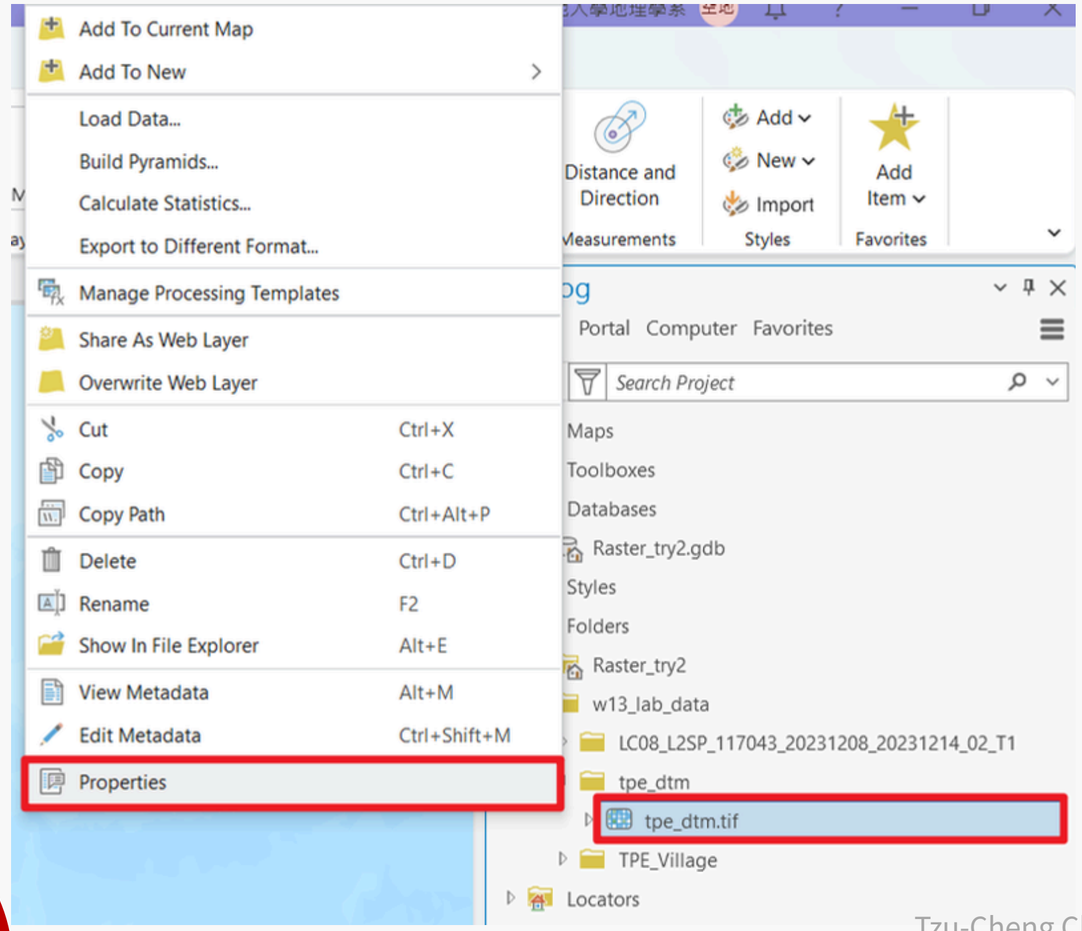
After erasing the flooding area, using remaining area and population density to estimate non-affected population.

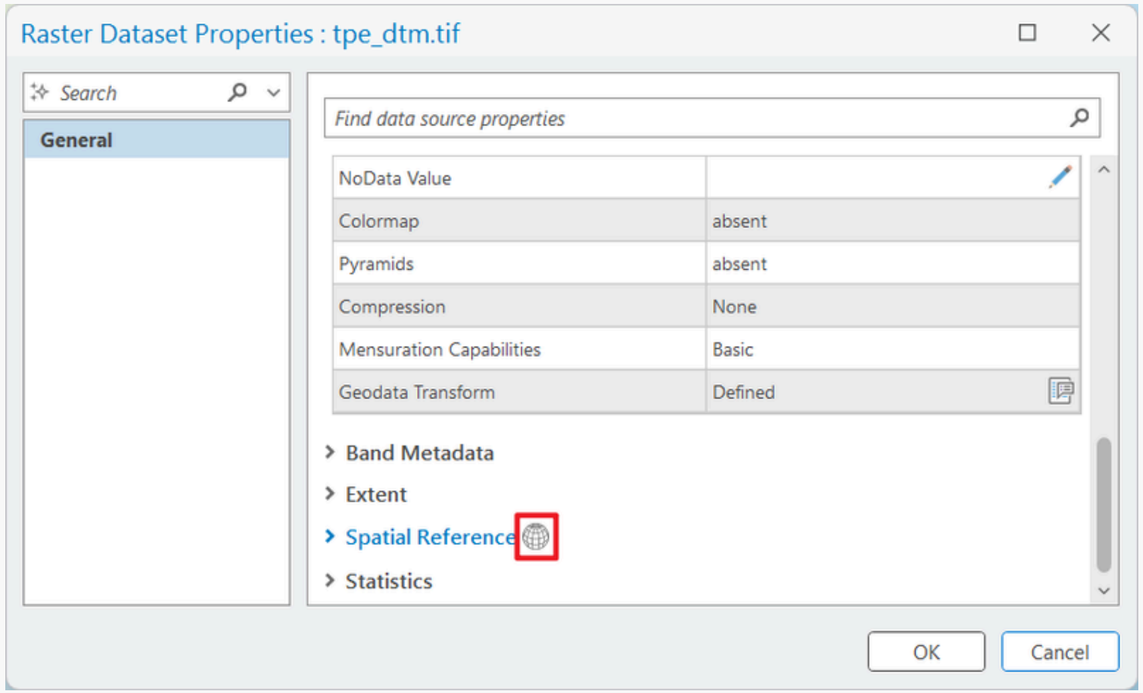
Flooding Potential Area - 20m

- Setting Coordinate System
- Raster Preprocessing
  - Reclassify
  - Raster Claculator
- Raster to Point
- Select by Attribute
- Point to Raster
- Raster to Feature

Flooding Potential Area

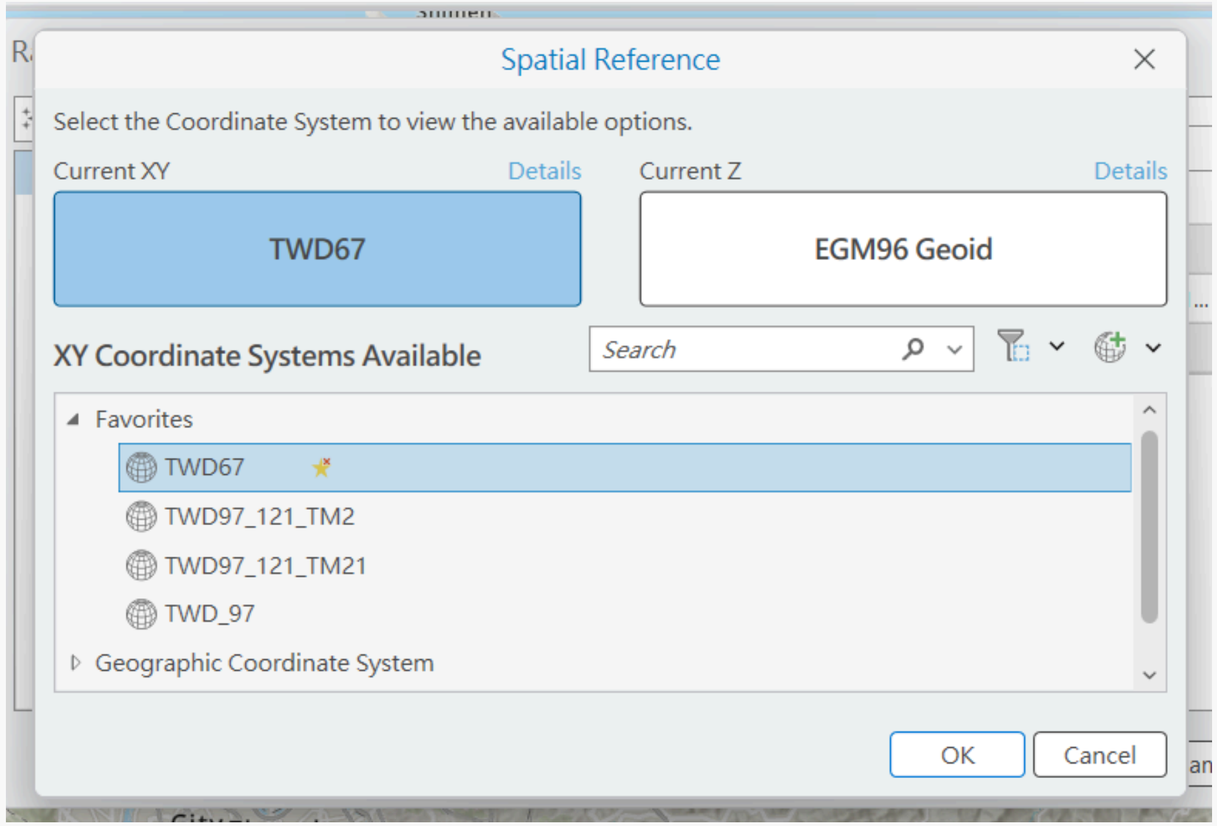
Setting Coordinate System

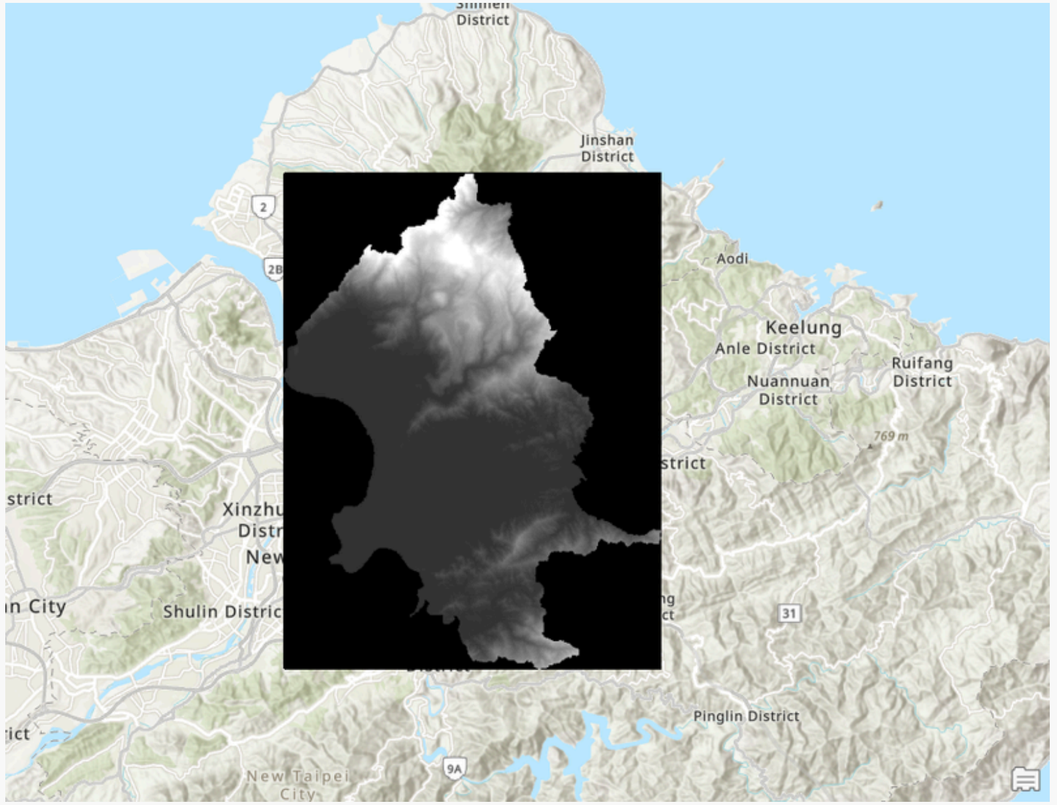




Flooding Potential Area

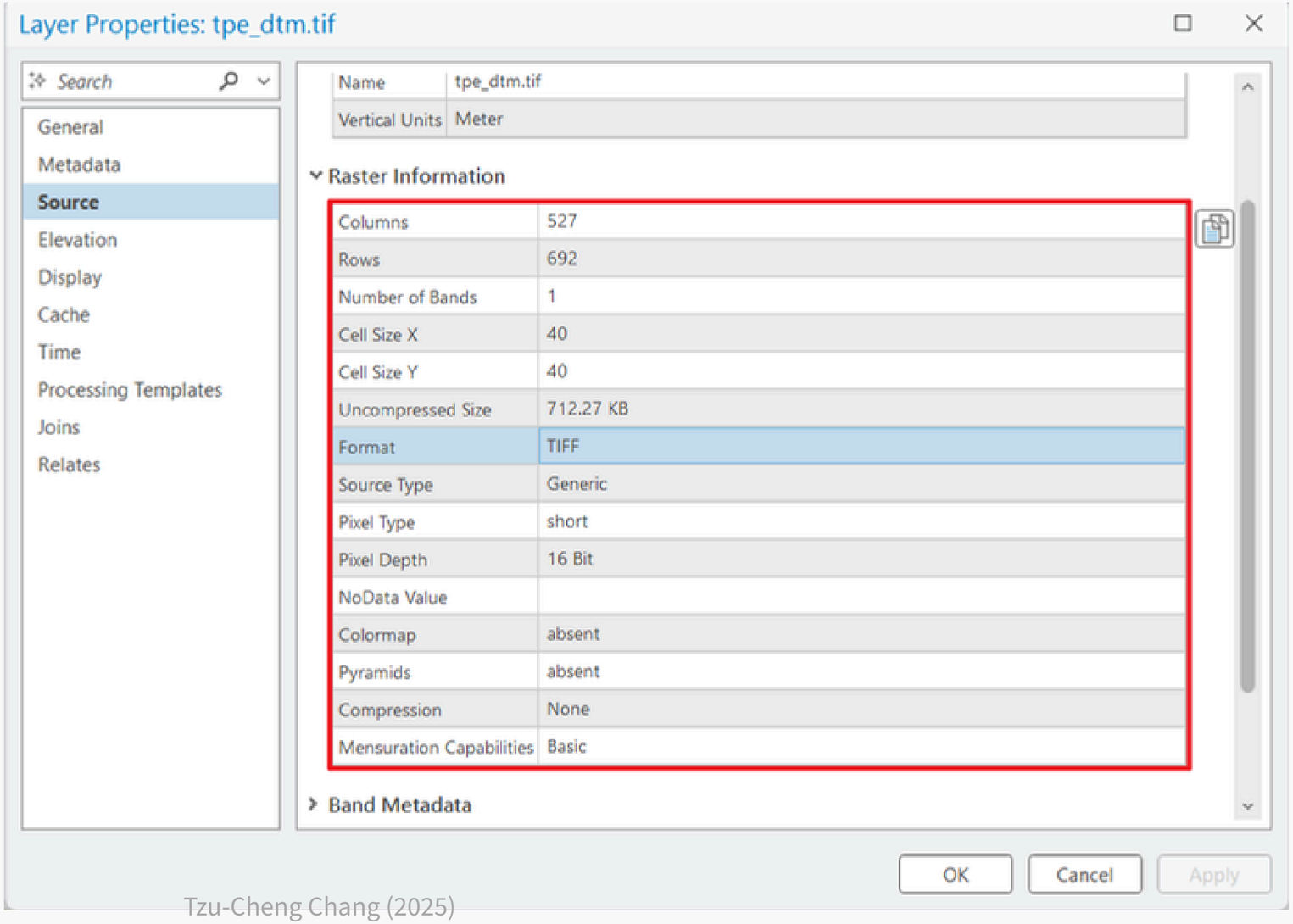
Setting Coordinate System





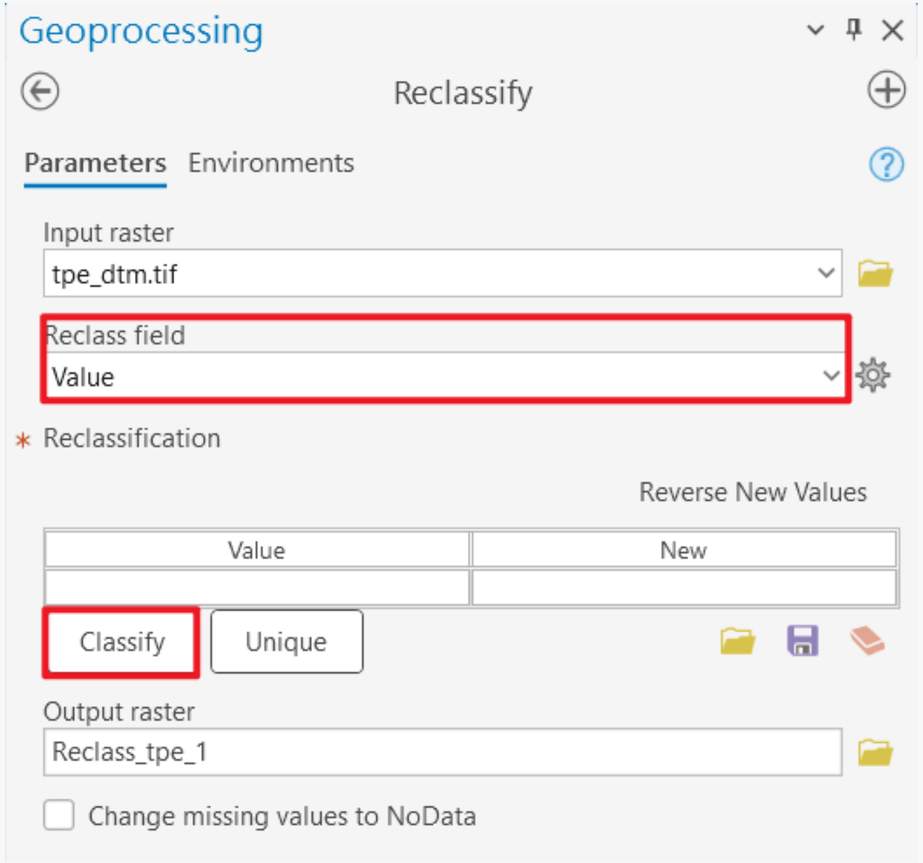
Flooding Potential Area

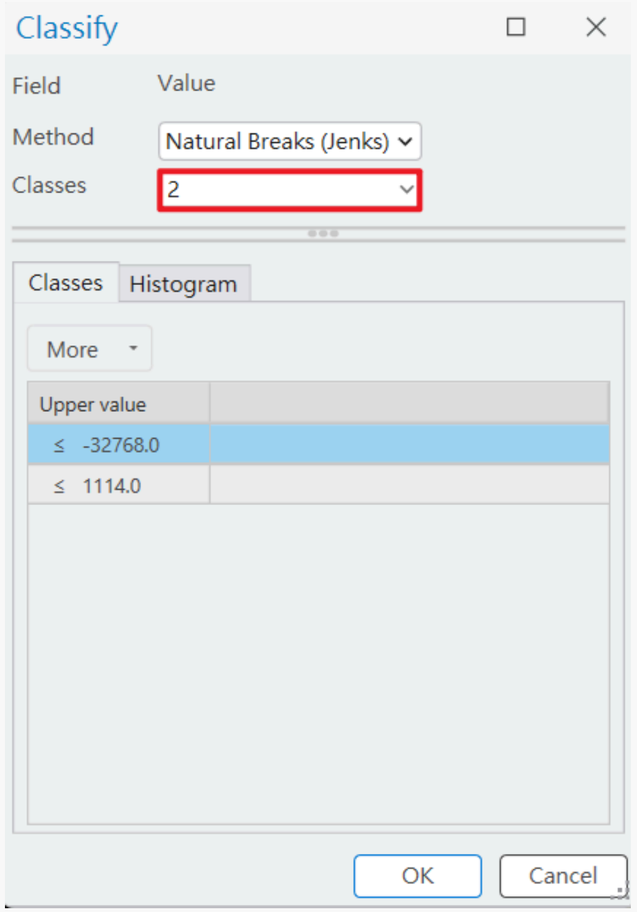
Raster Properity



Flooding Potential Area

Preprocessing - Reclassify





Flooding Potential Area

Preprocessing - Reclassify

Geoprocessing

Reclassify

Parameters Environments

Input raster

tpe_dtm.tif

Reclass field

Value

Reclassification

Reverse New Values

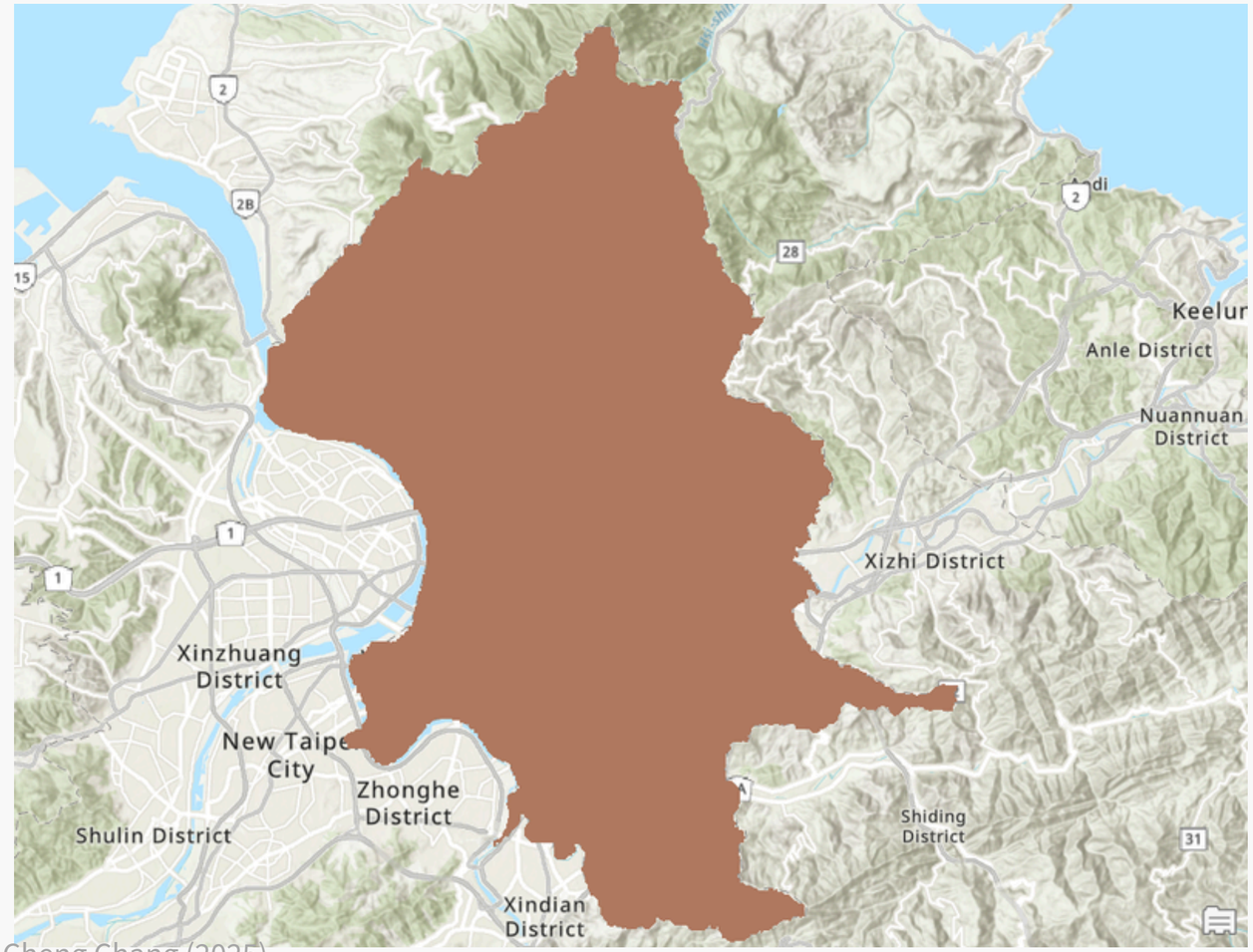
Start	End	New
-32768	-32768	NODATA
0	1114	1
NODATA	NODATA	NODATA

Classify Unique

Output raster

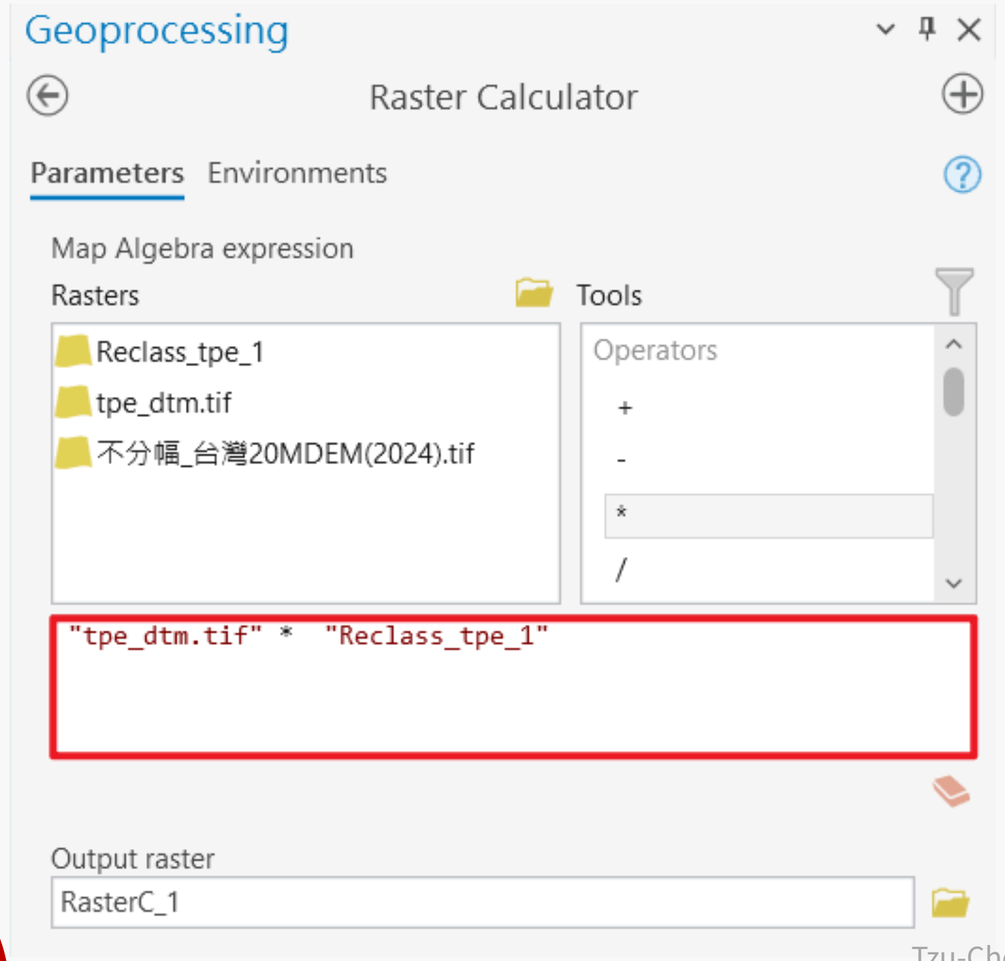
Reclass_tpe_1

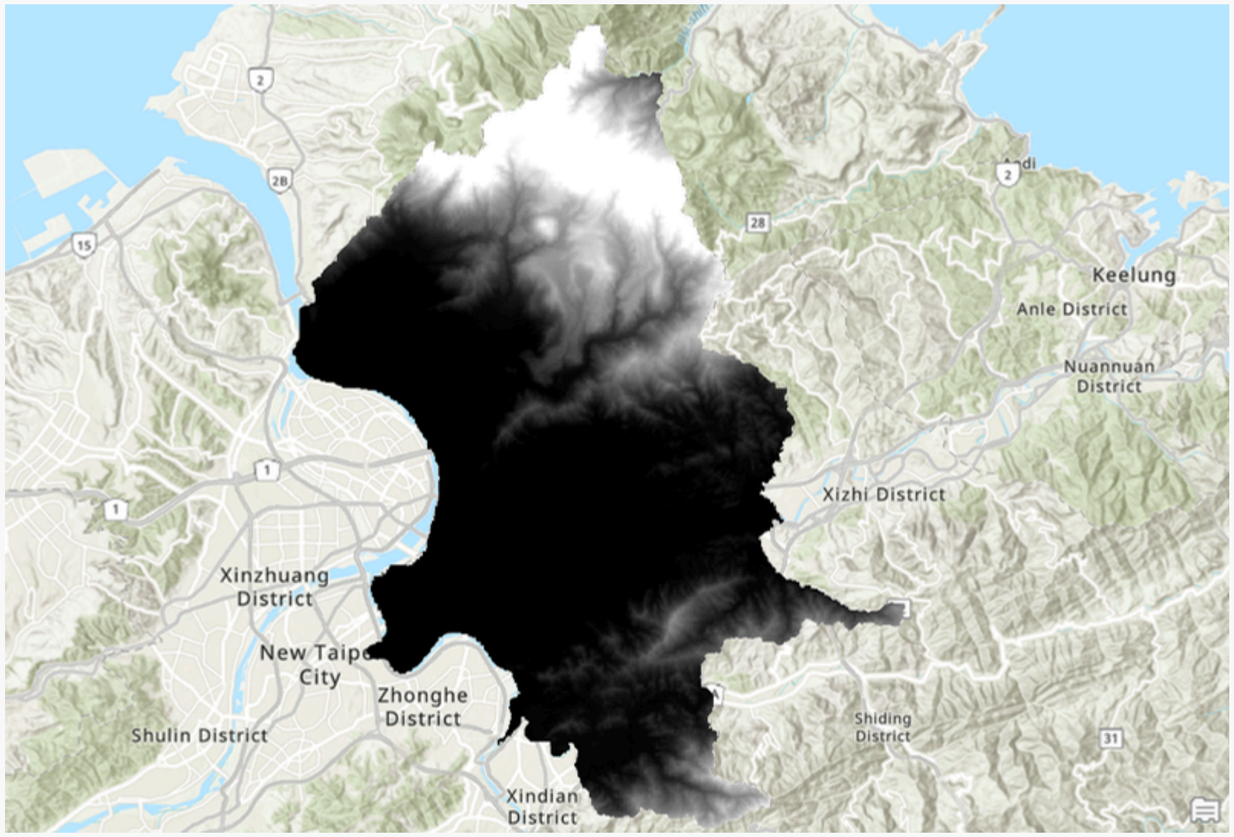
Change missing values to NoData



Flooding Potential Area

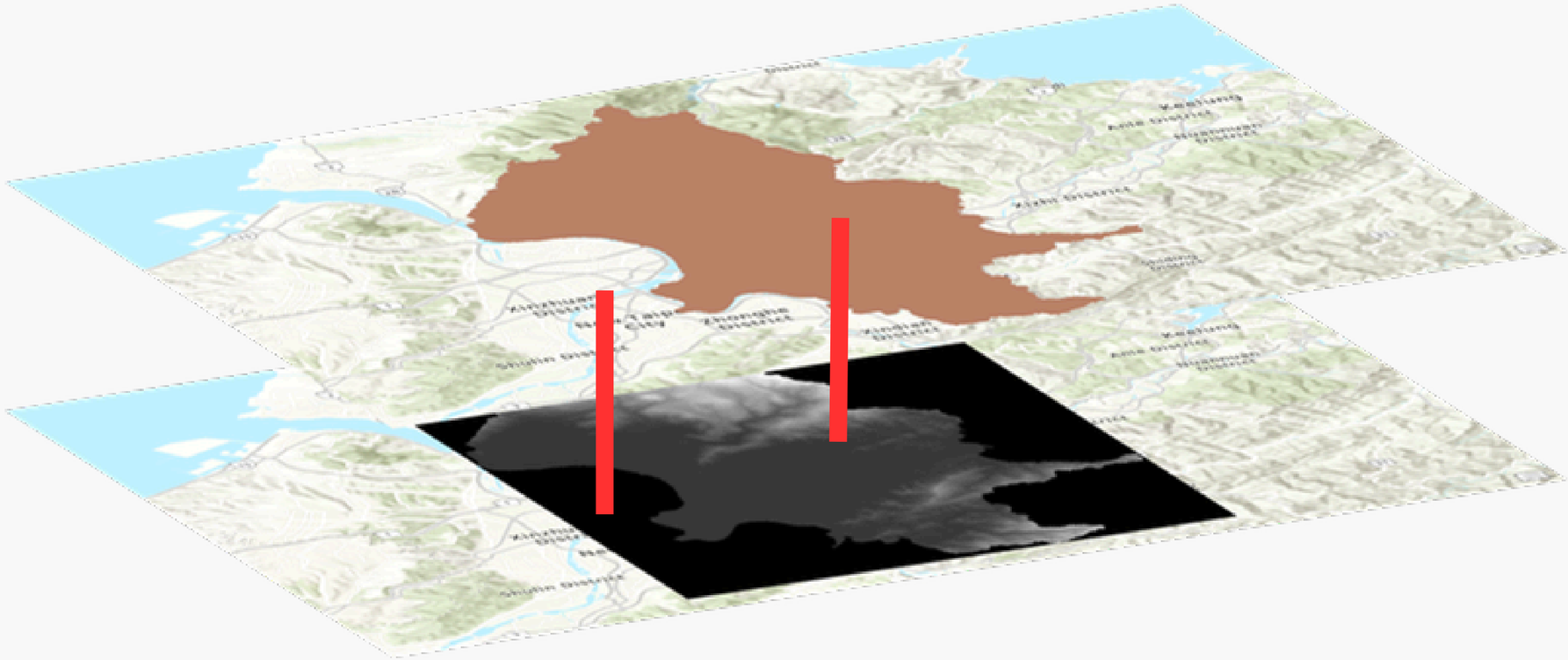
Preprocessing - Raster Calculator





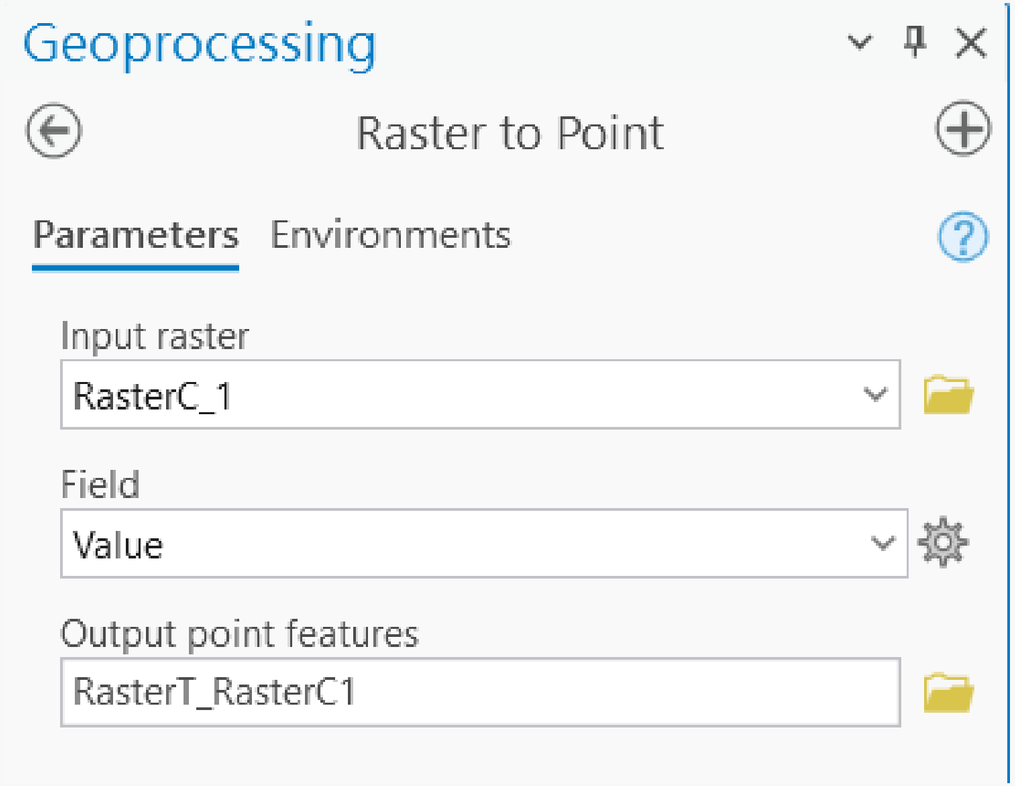
Flooding Potential Area

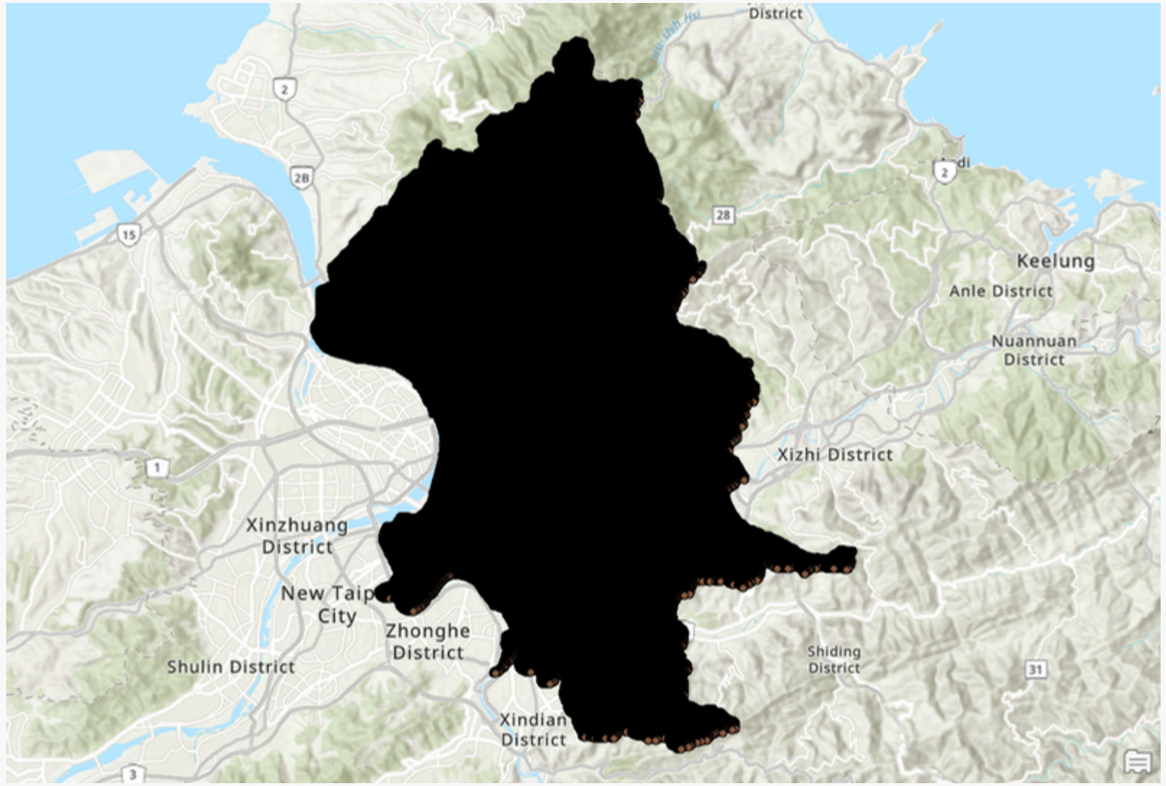
Preprocessing - Raster Calculator



Flooding Potential Area

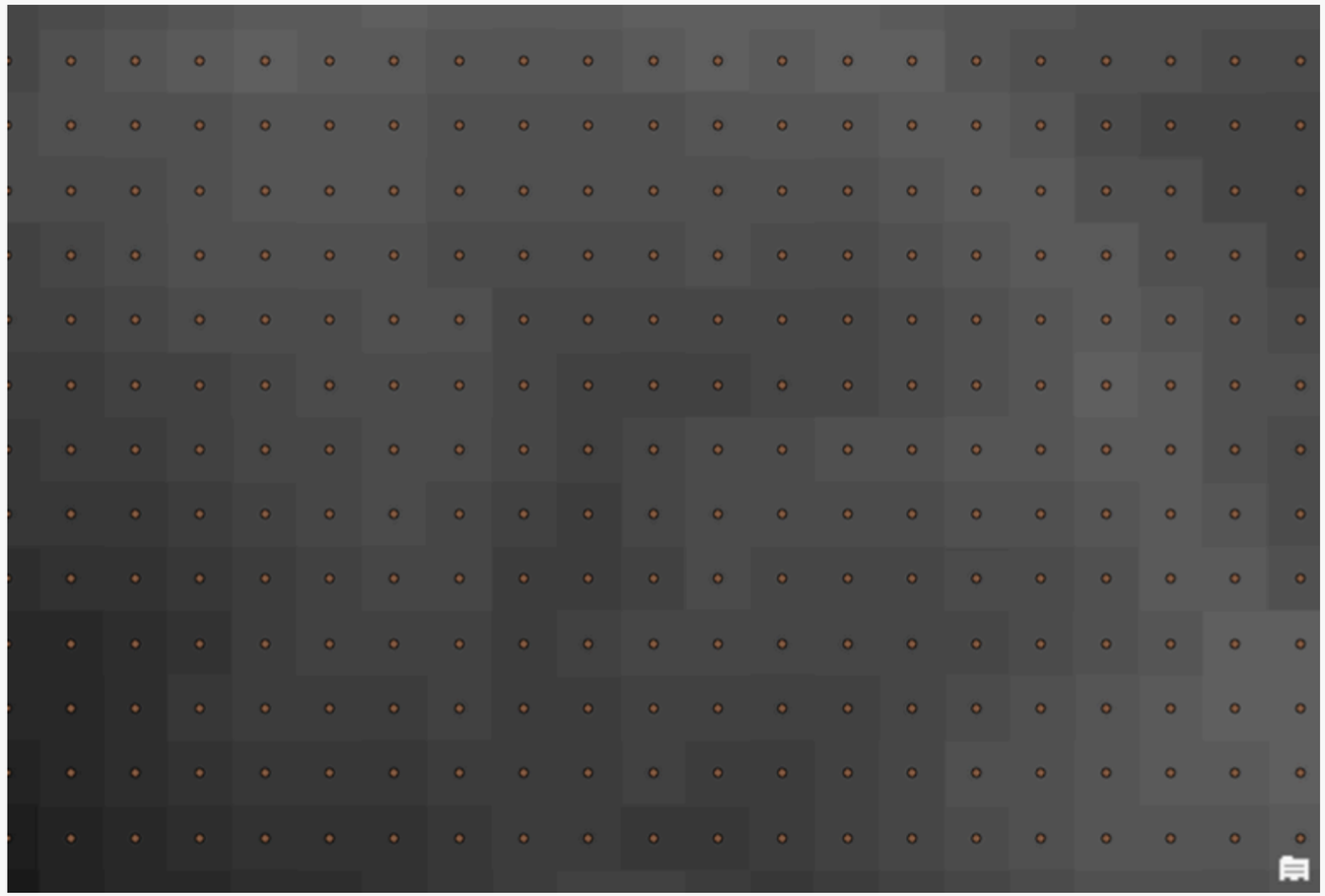
Raster to Point





Flooding Potential Area

Raster to Point



RasterT_RasterC1

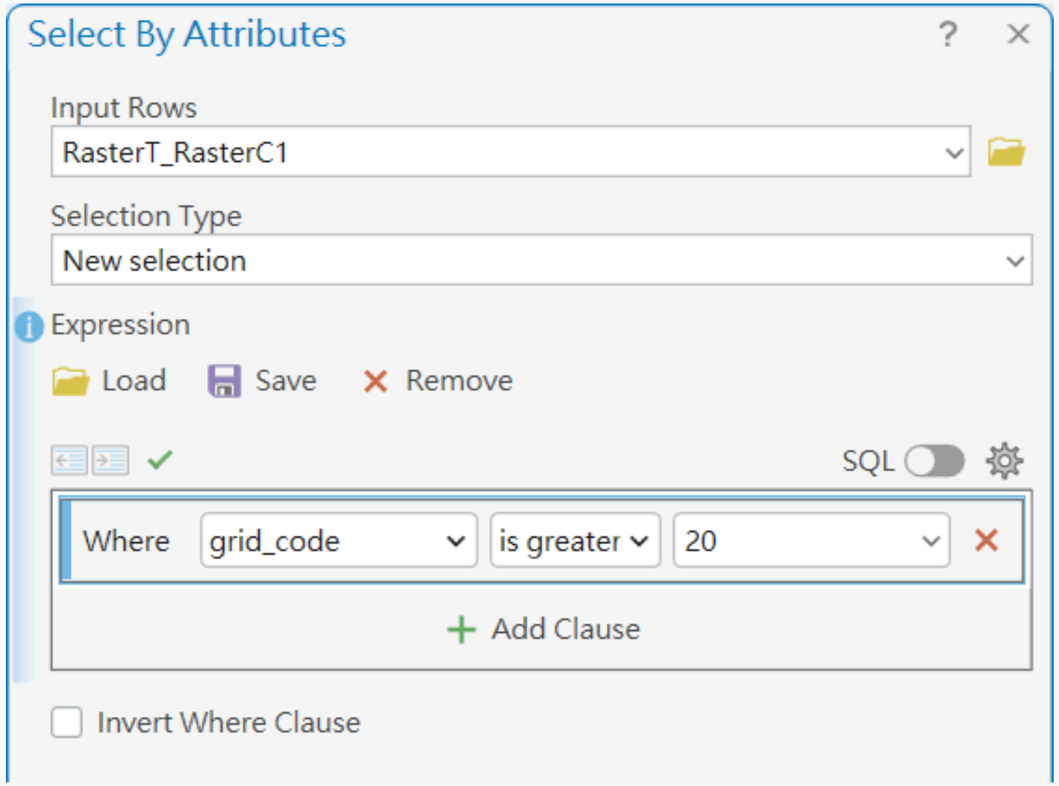
Field: Add Calculate Selection:

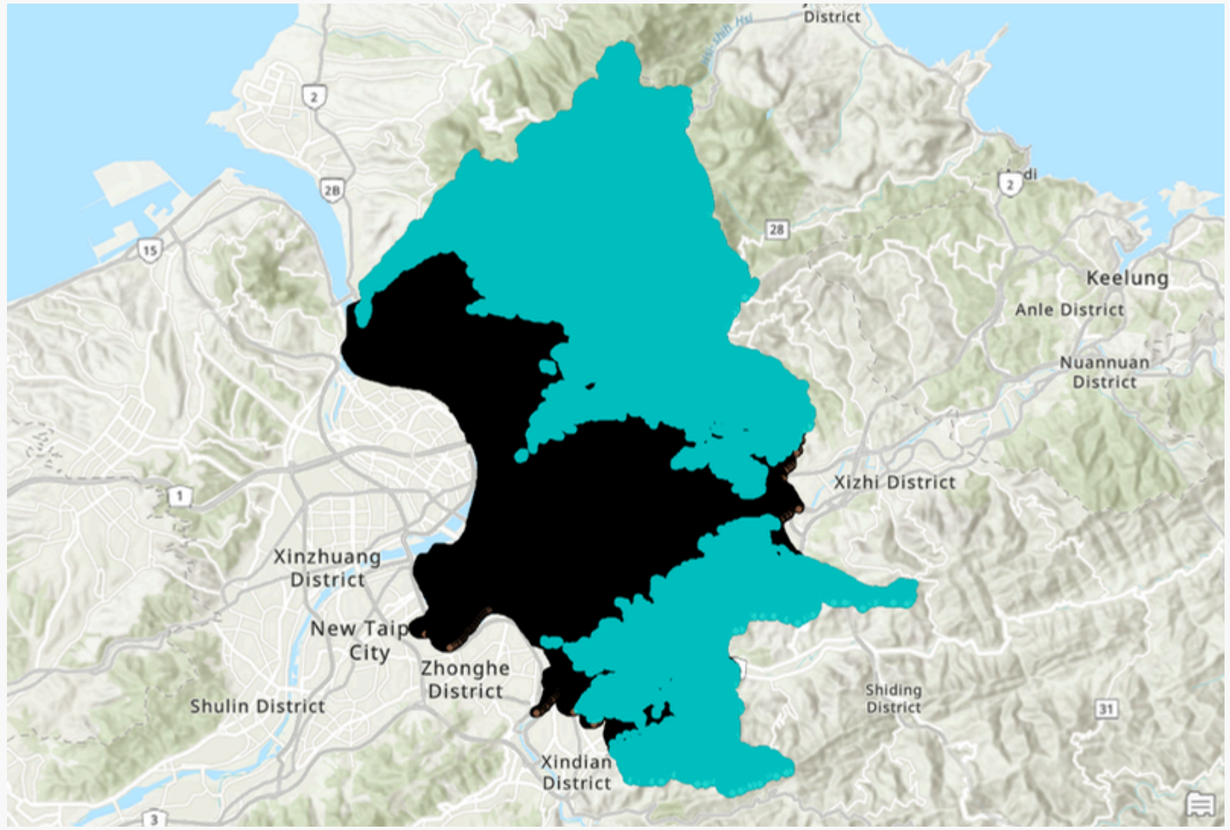
	OBJECTID *	Shape *	pointid	grid_code
1	1	Point	1	1036
2	2	Point	2	1029
3	3	Point	3	1034
4	4	Point	4	1034
5	5	Point	5	1016
6	6	Point	6	983
7	7	Point	7	974
8	8	Point	8	989

Elevation

Flooding Potential Area

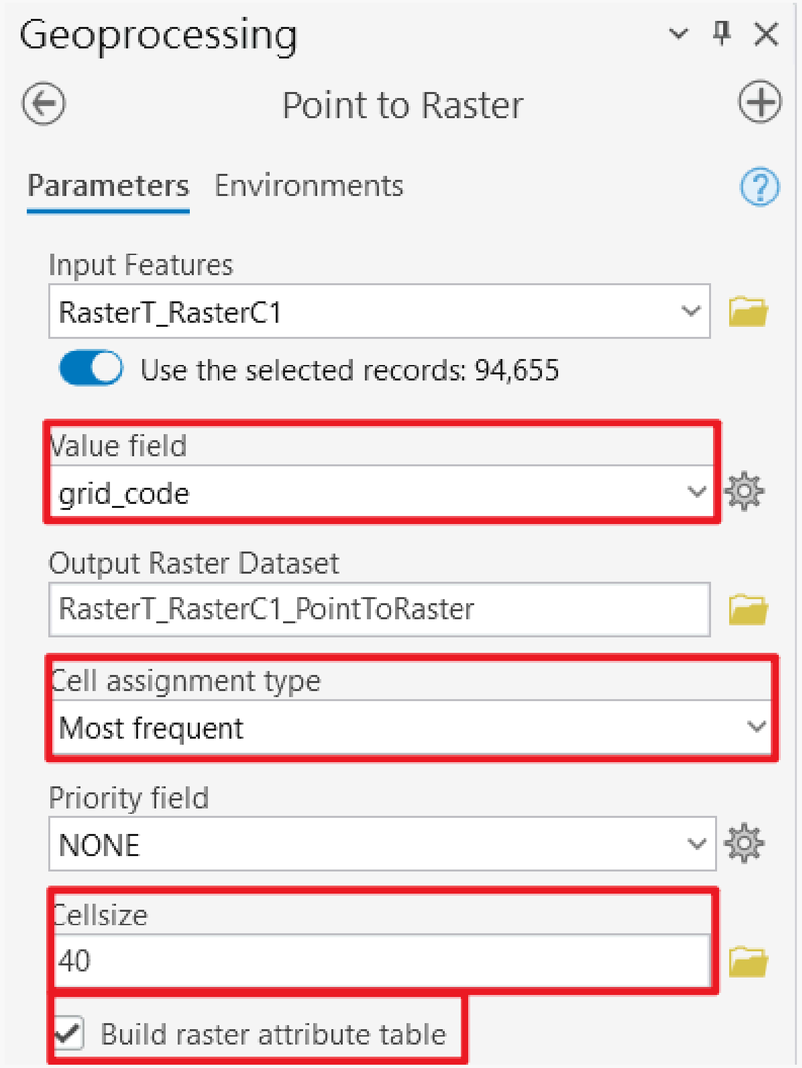
Select by Attribute => height above 20m

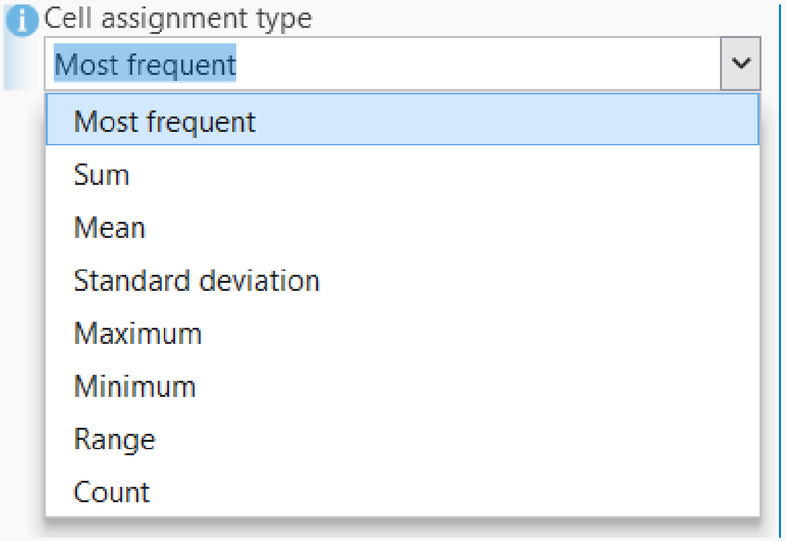




Flooding Potential Area

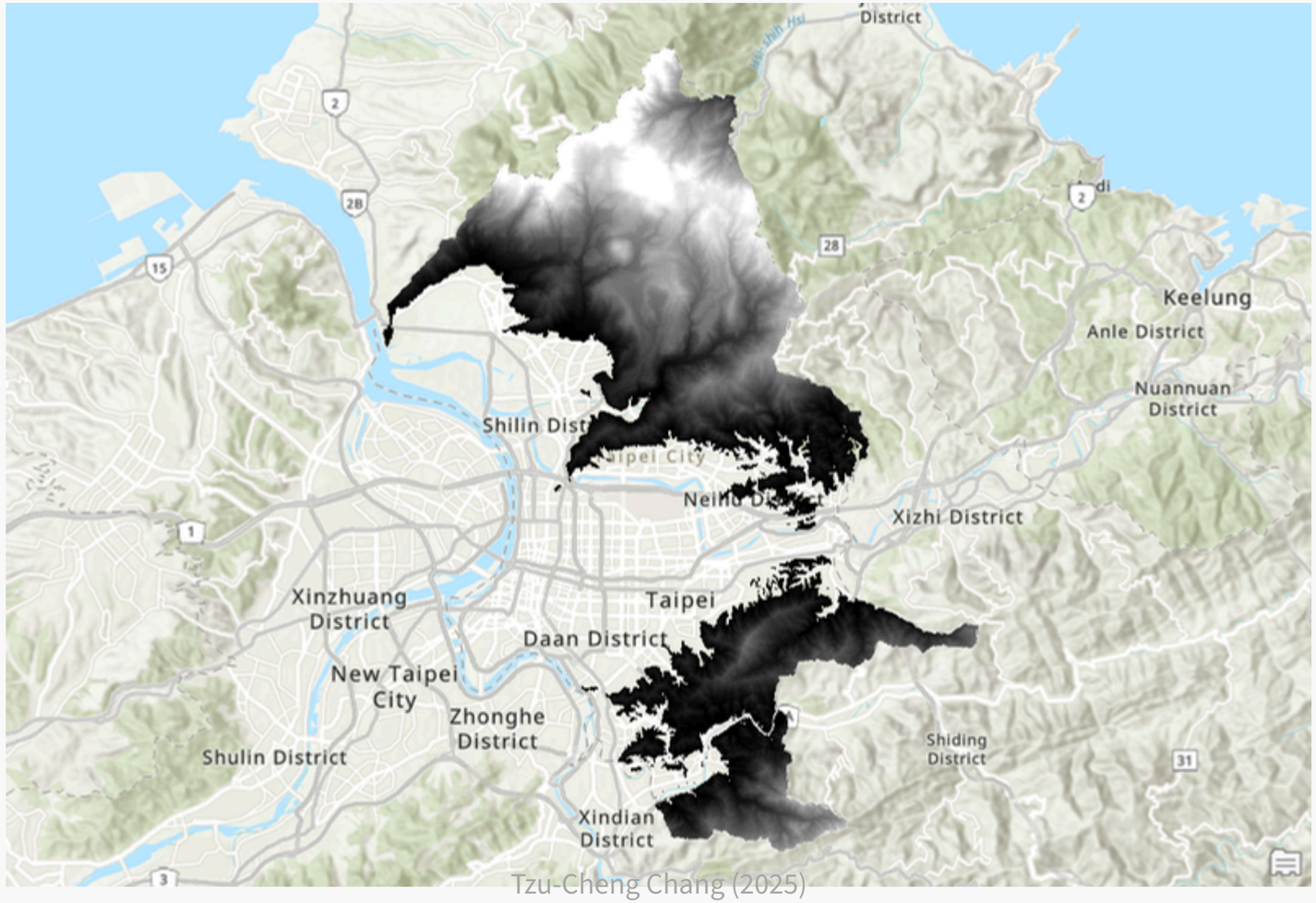
Point to Raster





Flooding Potential Area

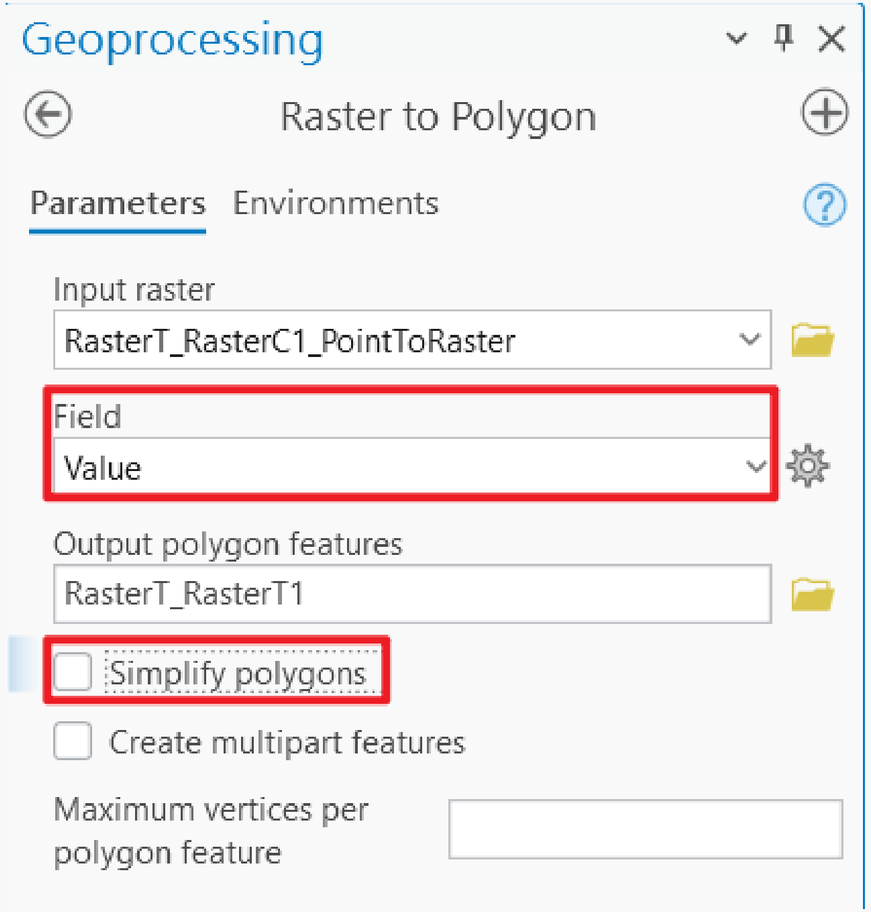
Point to Raster

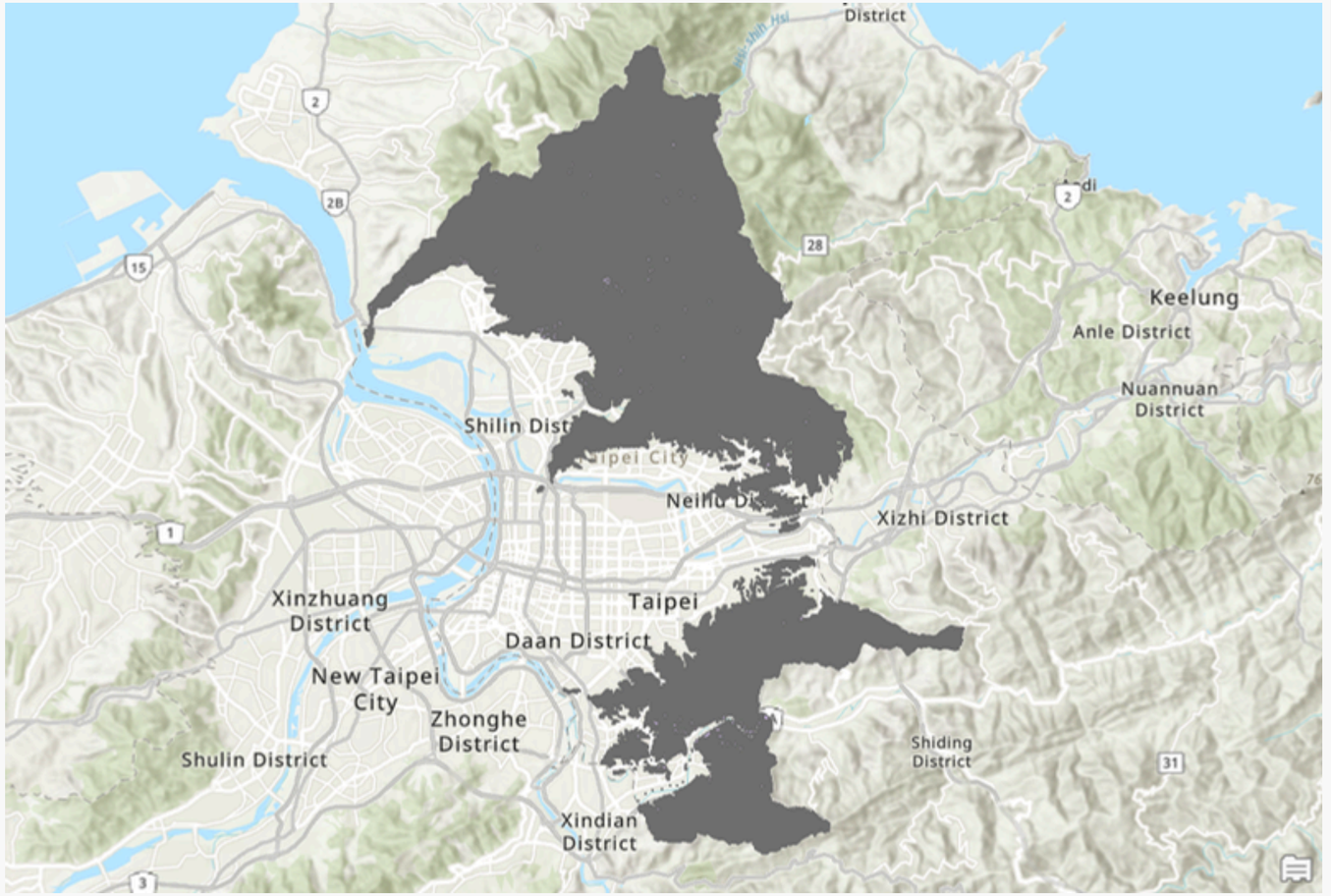


Tzu-Cheng Chang (2025)

Flooding Potential Area

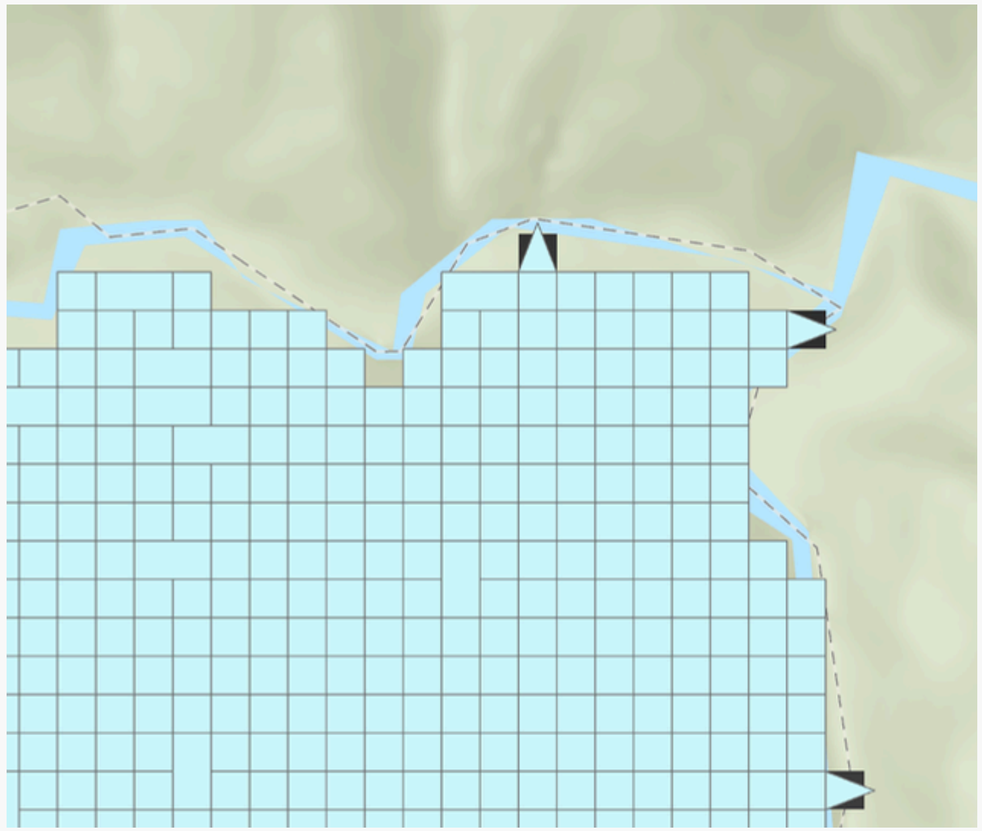
Raster to Polygon

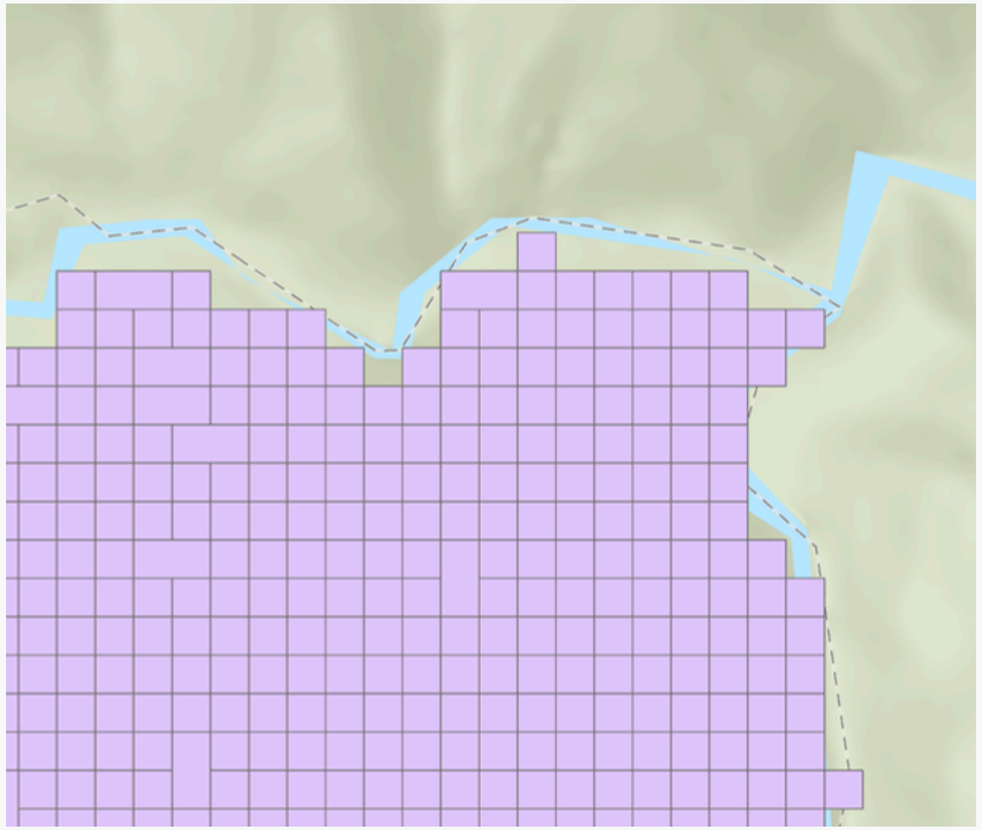




Flooding Potential Area

Raster to Polygon





Flooding Potential Area

- **Lab Practice I - Calculate total non-affected population with 20m height flooding area.**

intersect => calculate area & pop (P_DEN * area / 1000000) => dissolve

Plants Cover Estimation (NDVI)

Lab Practice II - Find the area that NDVI value greater than 0.4 .

Using the Point, Polygon and Raster convention to extract the target area.

After selecting NDVI point above 0.4, you will use point to raster make it a raster layer. To get the area in total, we need to transfer the raster into polygon.

Use Raster Domain to convert it into Polygon.

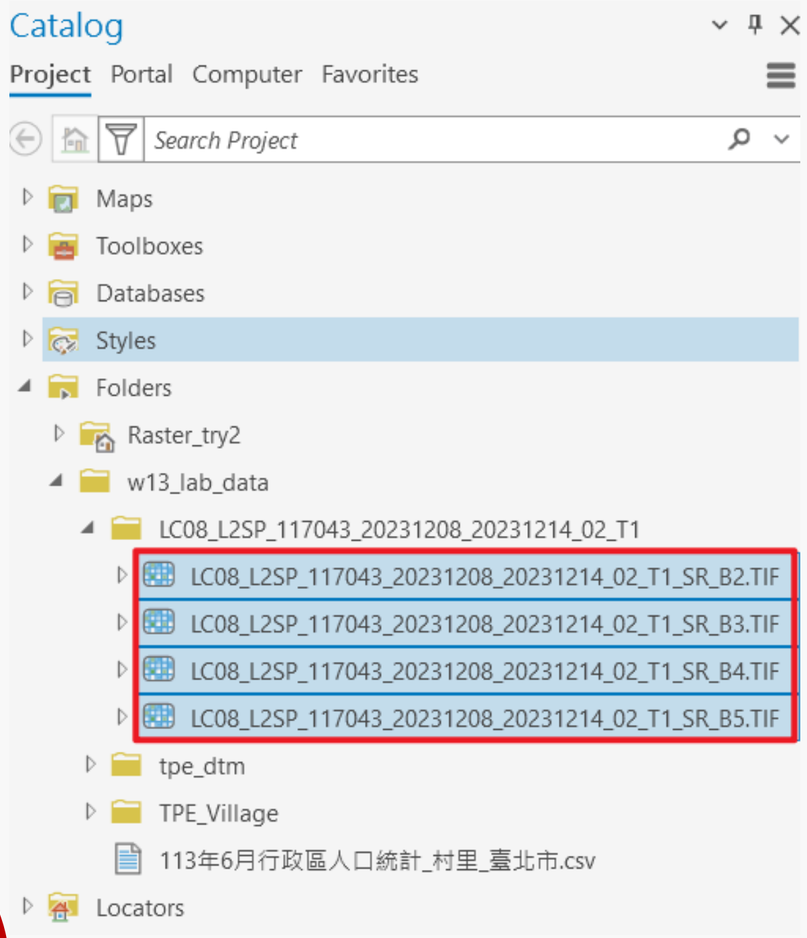
Notice the Cell size.

Plants Cover Estimation (NDVI)

- Composite the bands.
- Extract by Mask
- Using Symbology to Make False Color Imagery.
  - Symbology - Stretch Type
  - Statistics
- Raster Calculator

Plants Cover Estimation (NDVI)

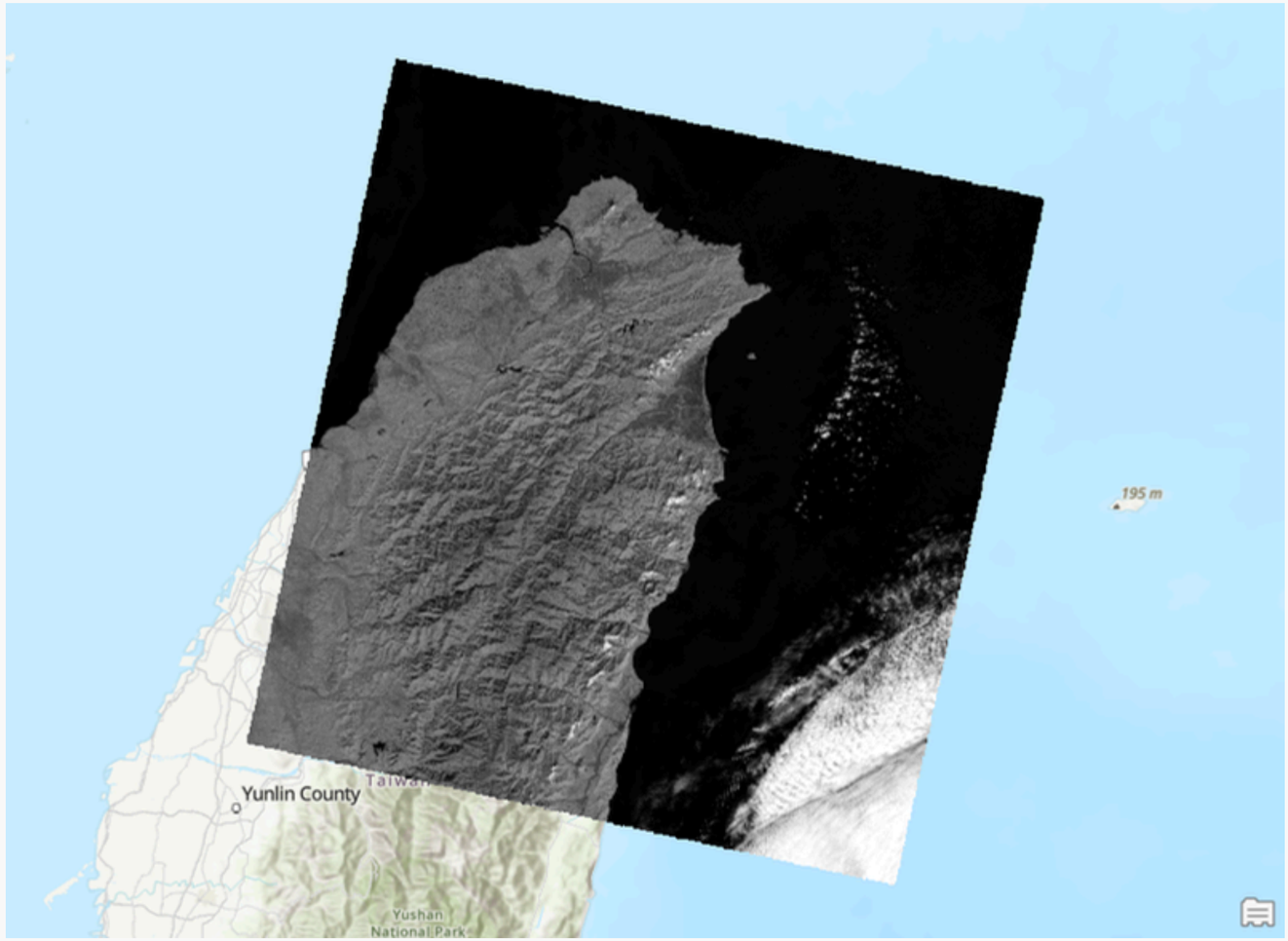
Composite the bands.



Channel	Landsat-8 OLI band (nms)	Center wavelength (nms)	Spatial (m)
Coastal/Aerosol	Band 1 (433–453)	443	30
Blue	Band 2 (450–515)	483	30
Green	Band 3 (525–600)	560	30
Red	Band 4 (630–680)	660	30
NIR	Band 5 (845–885)	865	30
SWIR 1	Band 6 (1560–1660)	1650	30
SWIR2	Band 7 (2100–2300)	2220	30
Panchromatic	Band 8 (500–680)	640	15
Cirrus	Band 9 (1360–1390)	1375	30

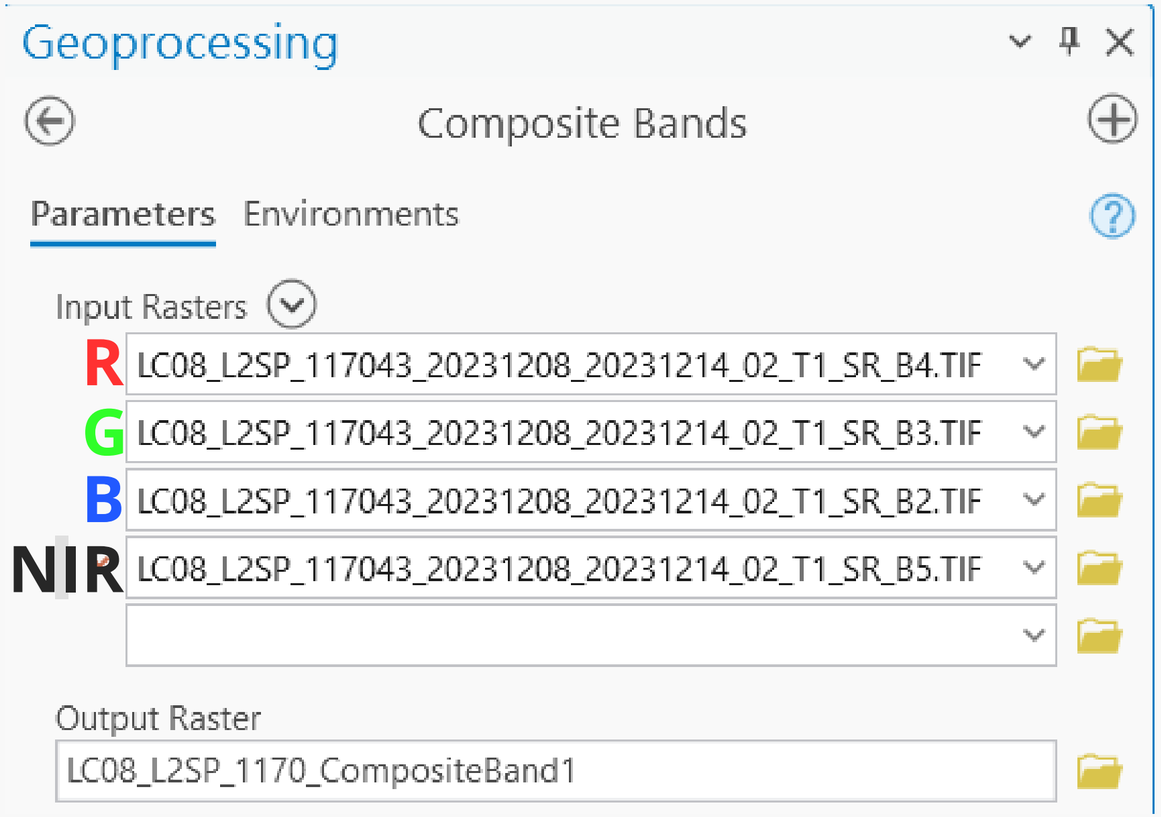
Plants Cover Estimation (NDVI)

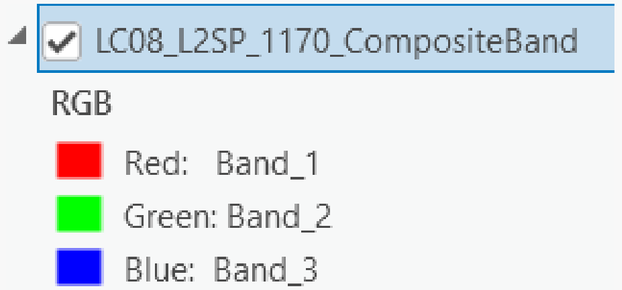
- **Composite the bands.**

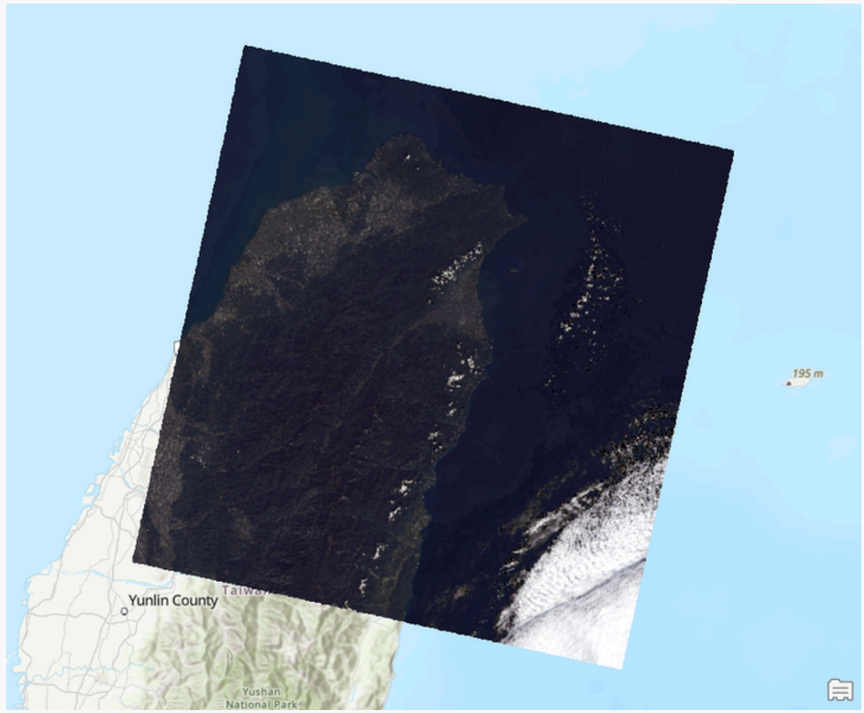


Plants Cover Estimation (NDVI)

Composite the bands.

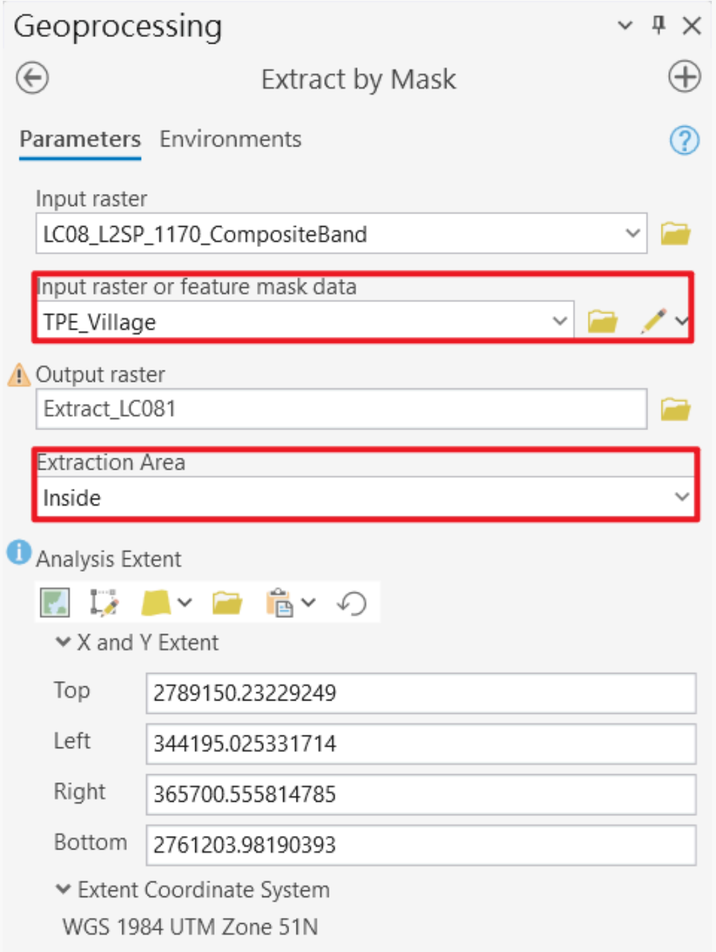


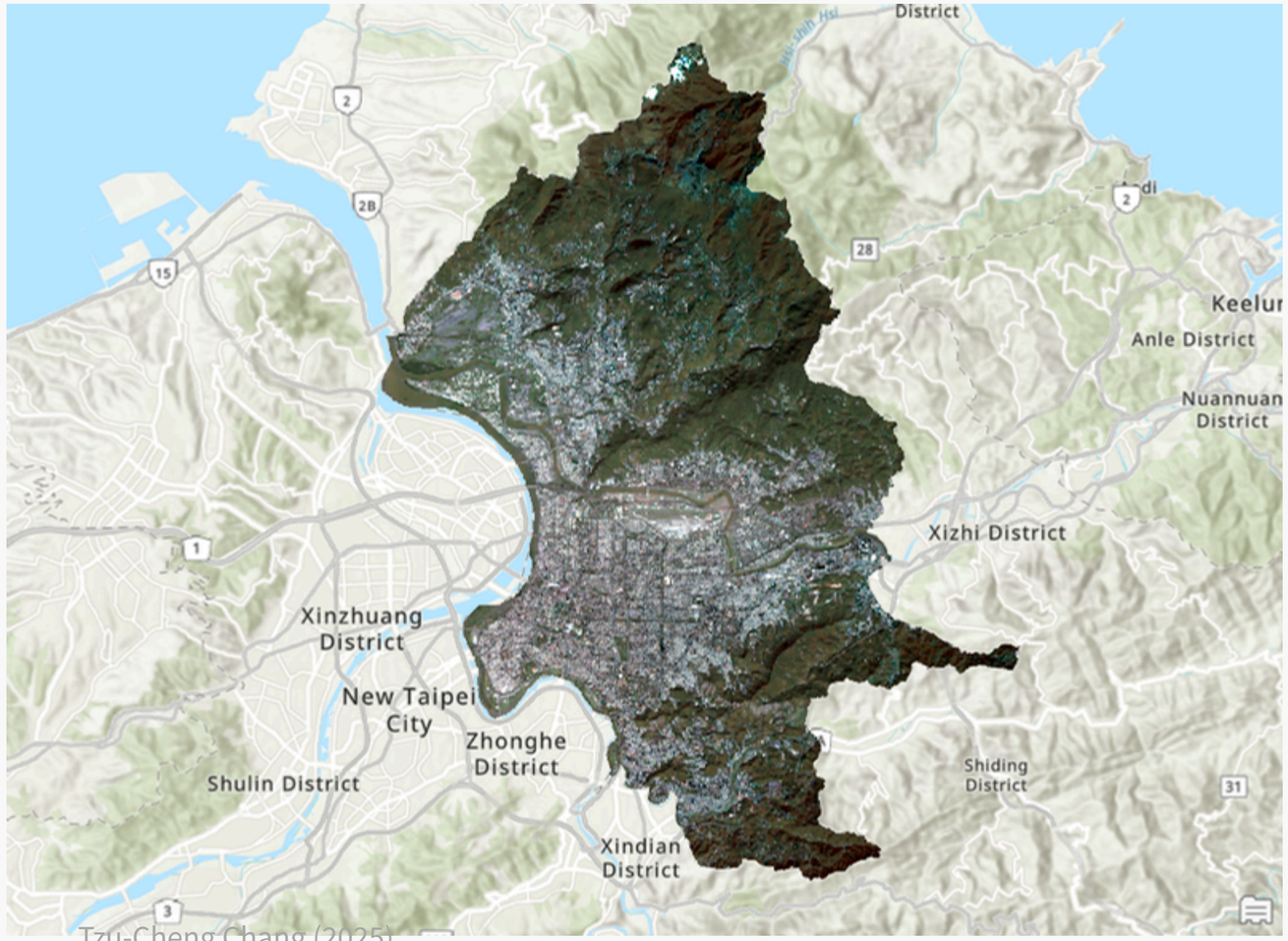




Plants Cover Estimation (NDVI)

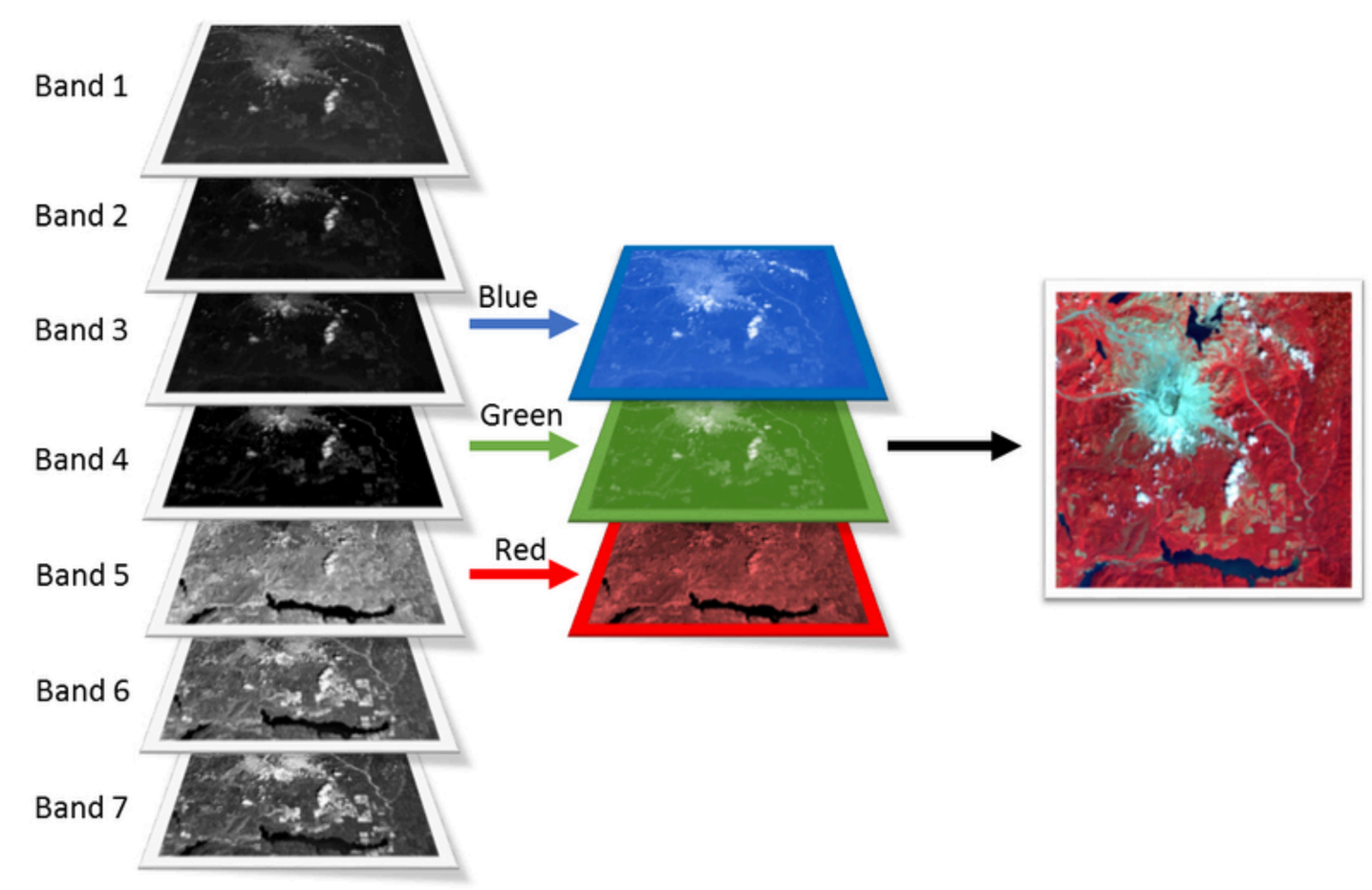
Extract by Mask

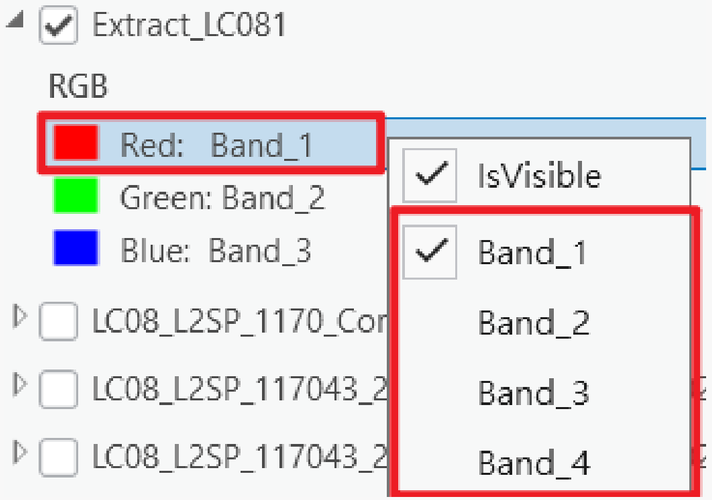




Plants Cover Estimation (NDVI)

True Color vs. False Color

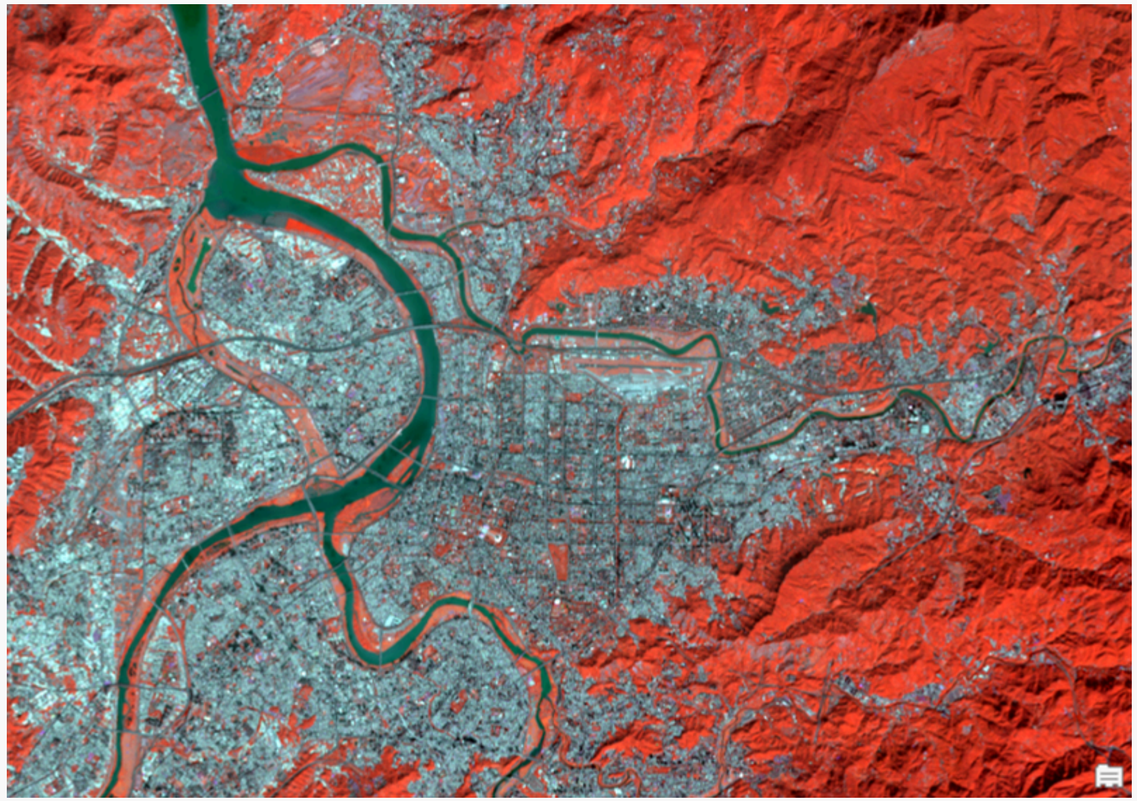




Plants Cover Estimation (NDVI)

True Color vs. False Color

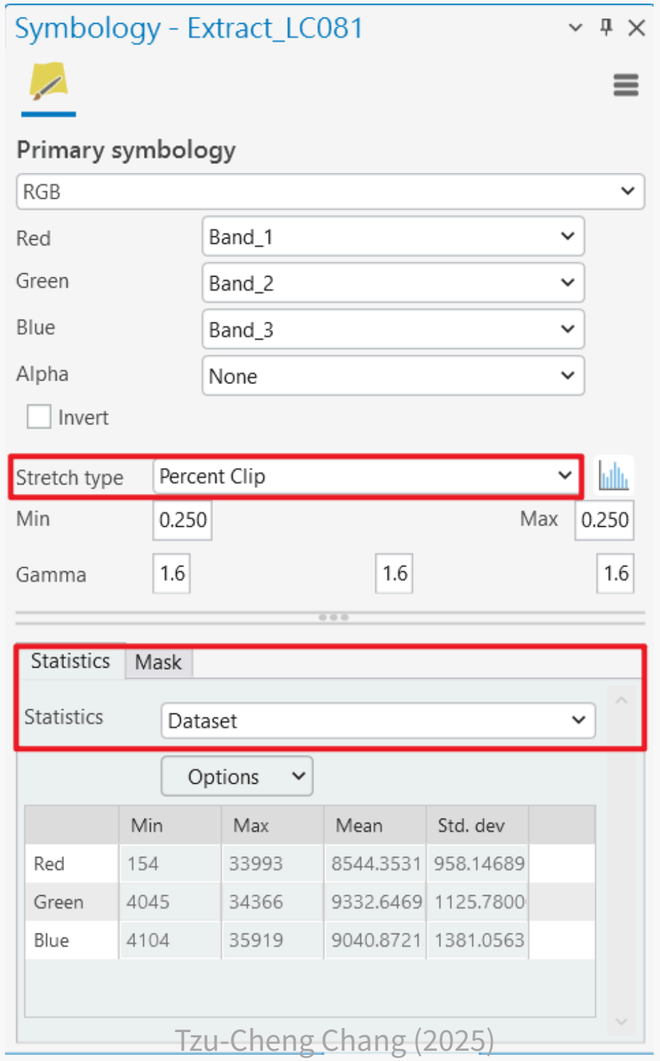
True Color

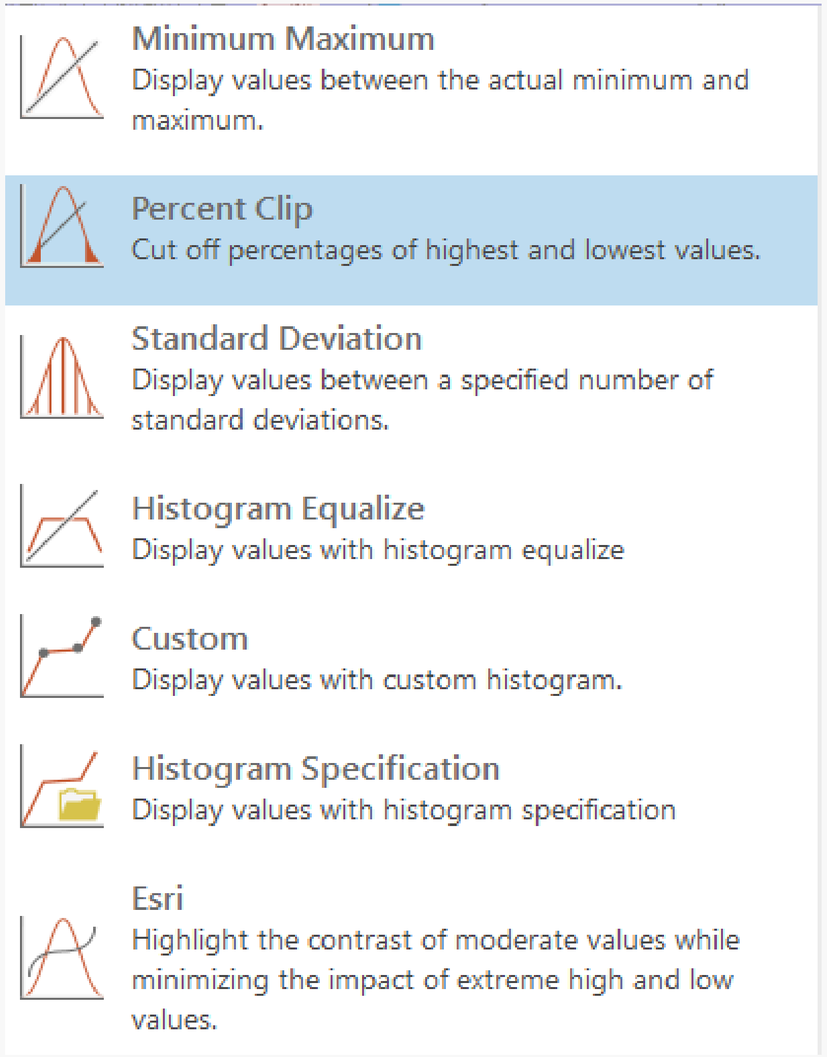


False Color

Plants Cover Estimation (NDVI)

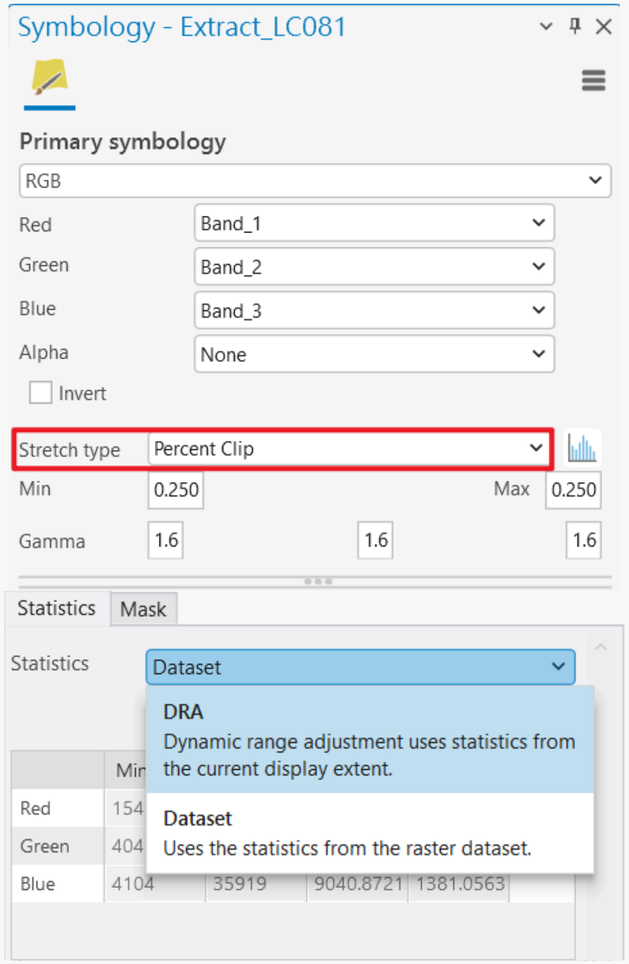
Raster Symbology





Plants Cover Estimation (NDVI)

Raster Symbology



DRA

Adjust from view scale.

Dataset

Statistic for all dataset.

Plants Cover Estimation (NDVI)

Raster Calculator

In NDVI, we need Red band and NIR band.

After our operation of composite bands,

band1 represents Red band,

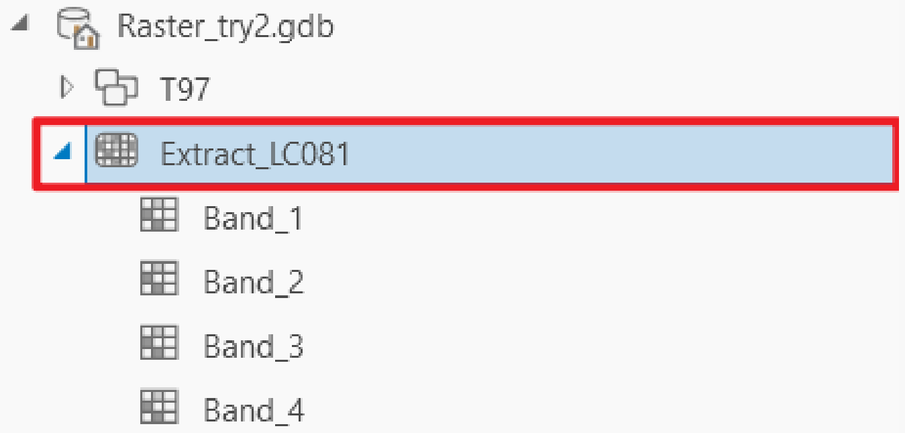
band4 represents NIR band.

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

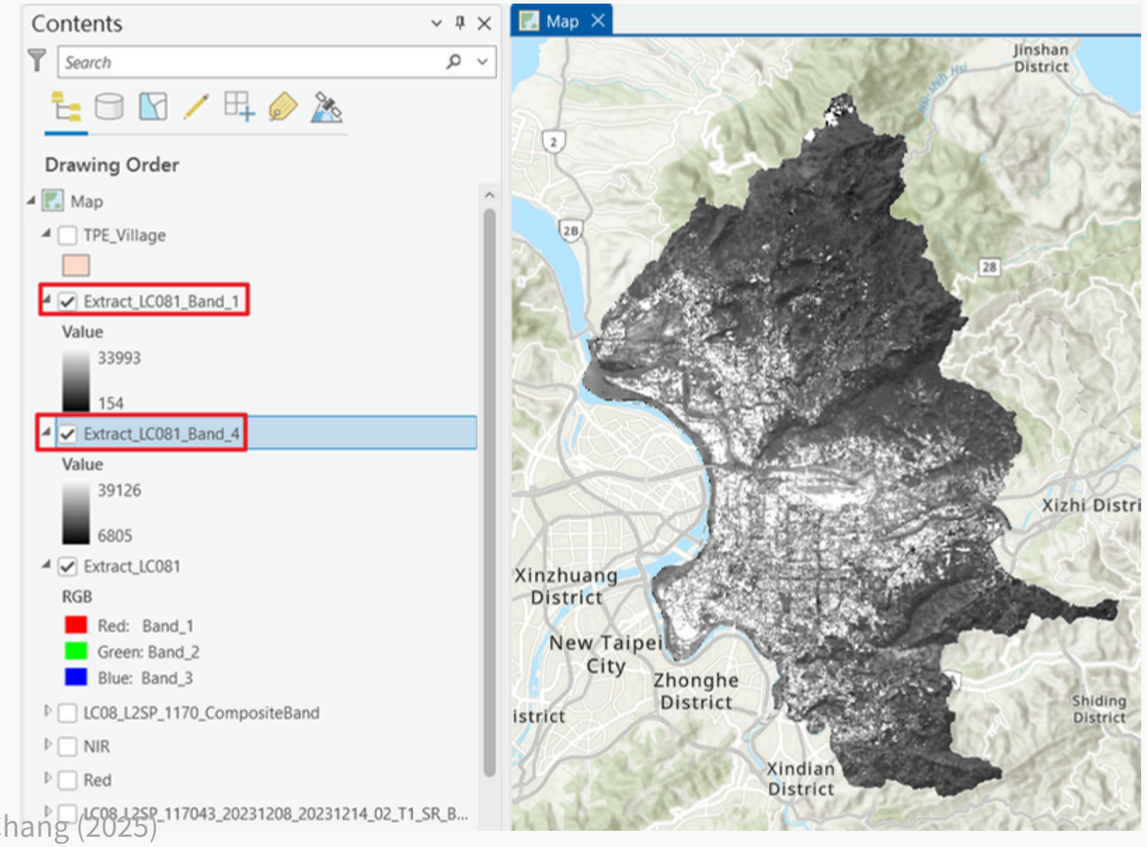
Plants Cover Estimation (NDVI)

Raster Calculator

Add single band from geodatabase.

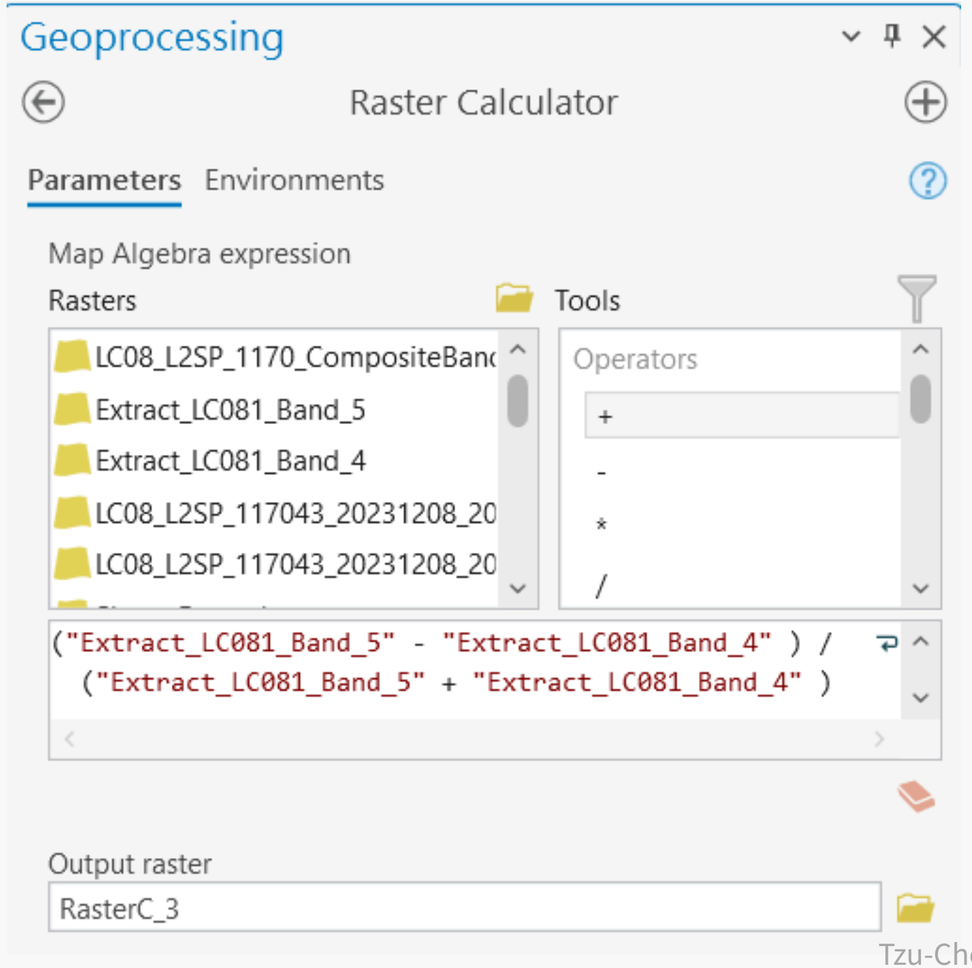


$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$



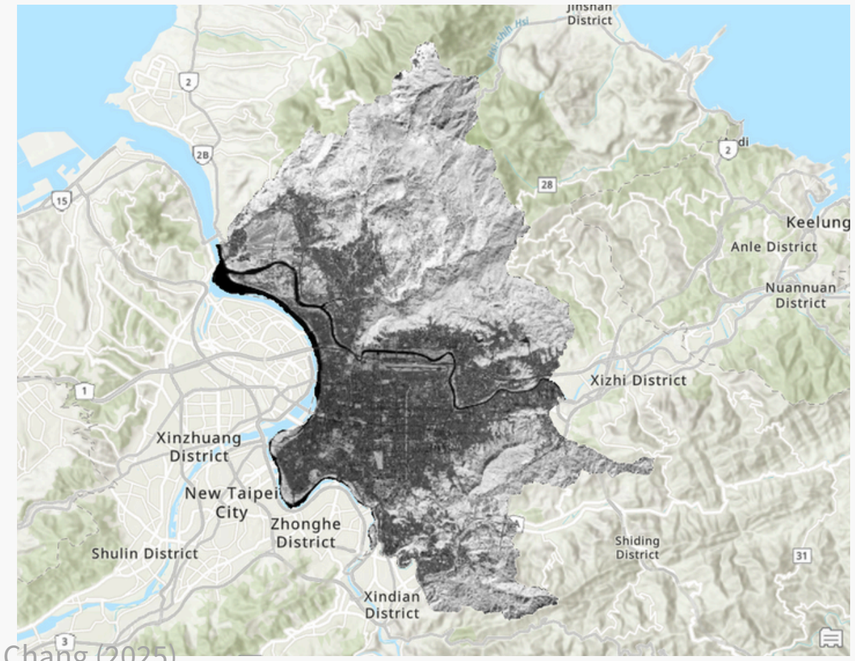
Plants Cover Estimation (NDVI)

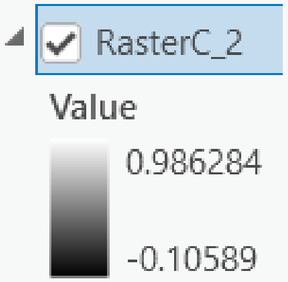
Raster Calculator



$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

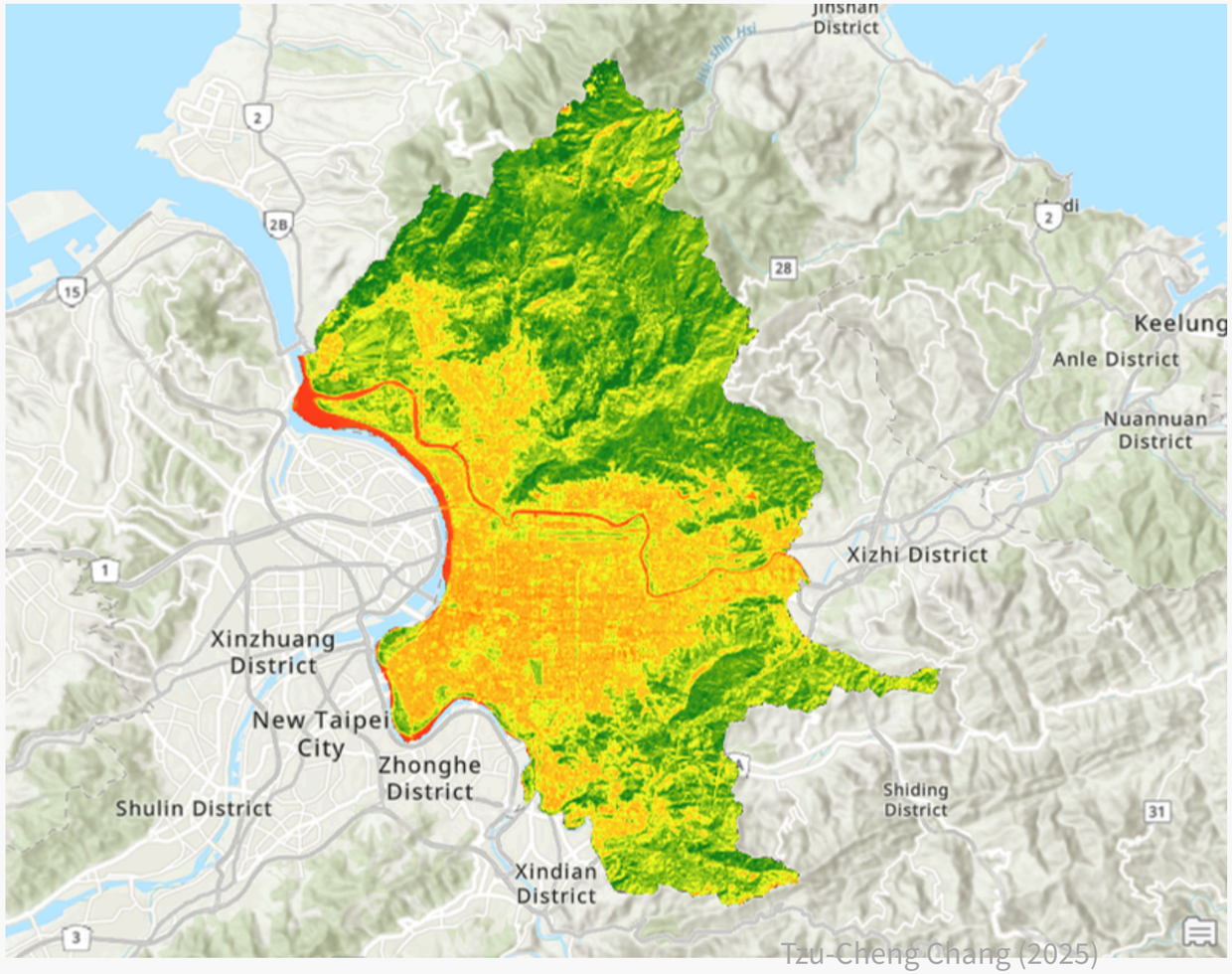
Value range: -1 ~ 1





Plants Cover Estimation (NDVI)

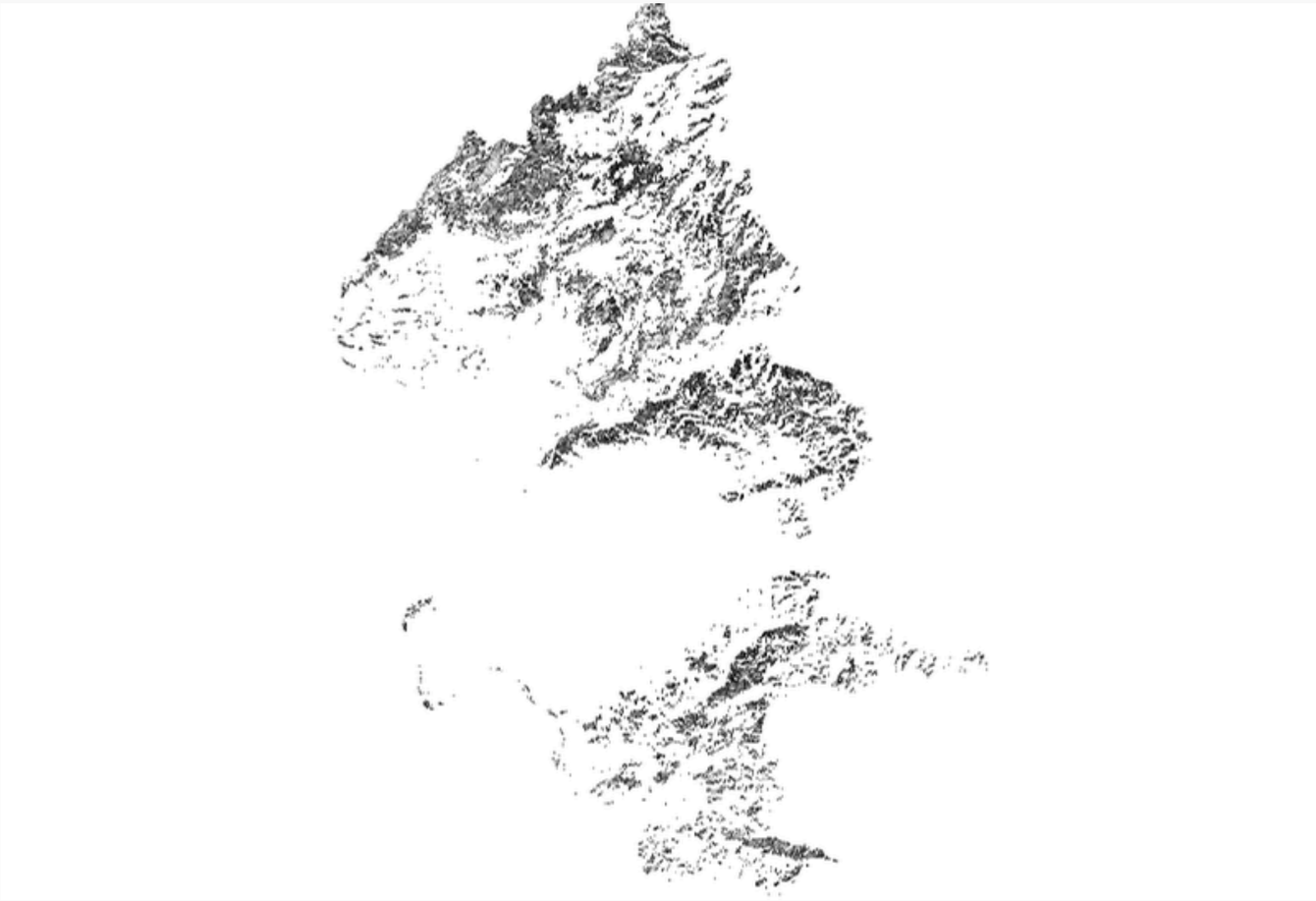
Raster Calculator



With symbology adjustment

Plants Cover Estimation (NDVI)

Point to Raster



Geoprocessing

Point to Raster

Parameters Environments

Input Features

RasterT_RasterC1

Use the selected records: 53,546

Value field

grid_code

Output Raster Dataset

RasterT_RasterC1_PointToRaster

Cell assignment type

Mean

Priority field

NONE

Cellsize

30

Build raster attribute table

Geographic
Information System

Thank You

05 DEC, 2025